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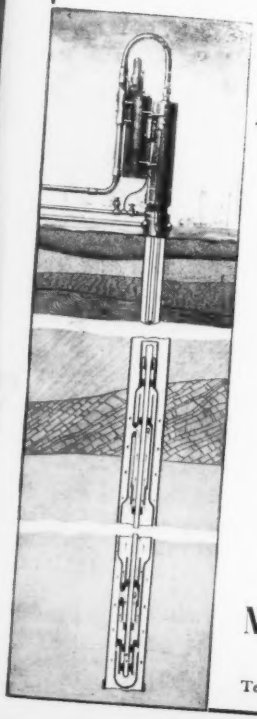

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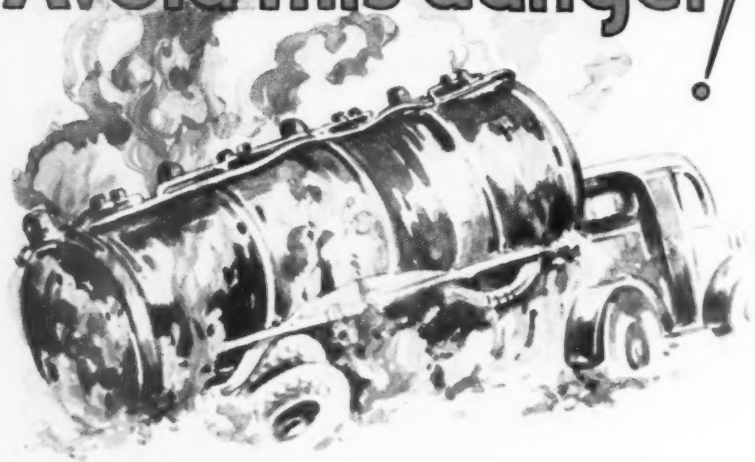

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FUEL AND POWER:

THE CONTRIBUTION OF OIL FUEL TO THE BRITISH FUEL PROBLEM

By G. RICHARDSON, B.Sc., A.R.S.M., M.Inst.Pet.*

INTRODUCTION

As a result of falling coal production and increasing heat and power requirements, Great Britain has now become a net importer of fuel whereas formerly she was a net exporter. Thus, one of the paramount needs of to-day, if we are to progress towards a higher standard of living, is to achieve *better results with less fuel.*

Every fuel has its own particular field of application in which it is superior to all others, and to create artificial conditions which favour one at the expense of another encourages waste and is, in the long run, against the national interest. To achieve the best results with the lowest practicable expenditure of heat may mean more than endeavouring to improve the method of burning the existing fuel; it may first be necessary to change the fuel, for there is at the present time a widespread tendency to use the wrong fuel for many purposes.

One such artificial condition resulted from the fuel oil tax, imposed in 1933. To quote Hansard of the day, the late Mr Neville Chamberlain, the then Chancellor, said:

* Secretary, Liquid Fuel Installations Committee of the Institute of Petroleum.

"I have received very strong representations from the coal industry, supported by the gas and electricity supply industries, and by the railway companies that in the interests of the British coal and allied industries I should review what they regard as an anomalous position."

The tax succeeded merely in checking development despite the resulting increase in the cost of oil to the consumer, and this is a measure of the superiority of fuel oil for certain applications. Oil is a liquid fuel with all that that implies and, in its own particular sphere, solid fuel, gas or electricity cannot be wholly satisfactory substitutes.

Present conditions of fuel scarcity necessitated removal of the tax after it had been in force for thirteen years, because it was a definite hindrance to the use of oil which the Government now wish to encourage. The effect during that period has been to prevent oil being used for many processes for which it is particularly adapted and to encourage the extravagant use of coal for producing gas and electricity in substitution. As a result, some of our most important industrial processes are, technically, many years behind their American counterparts.

The last twenty years has seen a large and increasing demand from both industrial and domestic consumers for heat in a clean and controllable form. In the U.S.A. this has been largely met by oil, natural and manufactured gas, and, of course, electricity generated from water power. In Great Britain there has been a small increase in the use of oil in certain fields, but the main demand has been met by increased consumption of gas and electricity. The latter trend is clearly indicated in Table I and Fig. 1, and the encouragement of it by preferential tariff rates, particularly those promoting domestic and other heating by electricity, has led directly to to-day's unmanageable peak loads. Such tariffs are often accompanied by conditions of sale which discourage the installation of oil-engined generators, and even prevent the use of existing plant of this type. It is, in fact, arguable that there would not now be any real shortage of heat and power in Great Britain had the natural development of the most efficient use of fuels generally not been interfered with by fiscal measures and preferential charges.

HOW MUCH OIL?

The main consideration that ought to dominate this question is that in Great Britain imported oil should not be used merely as a substitute for coal—rather should it be used for those applications in which it is economically and technically superior. In certain circumstances industrial progress may make it necessary to import oil and export the coal it replaces, and it should be recognized that this exchange may be—as it certainly is to-day—to the national advantage.

In his paper on "Fuel and Power", Mr G. Richardson, Secretary of the Liquid Fuel Installations Committee of the Institute of Petroleum, has presented a reasoned statement of the part which petroleum fuels should play in the British fuel economy. The inefficient use made of fuel in Great Britain is clearly shown, particularly in the diagrams, and the article points out that this is largely due to the wrong fuel being selected for use in particular applications.

That such inefficient use of fuel does occur is generally known to fuel technologists, but is not so widely appreciated by other sections of the community.

F. H. GARNER
Hon. Editor

TABLE I

Annual Coal Production and Exports
and
Usage of Coal and Oil for Gas and Electricity Generation in Great Britain

Coal—million tons
Oil —million gallons

Year	Coal production	Fuel Consumption for Gas making		Electricity generation (coal)	Coal exports
		Coal	Oil		
1933	207	17	54	10	53
1934	221	18	40	11	53
1935	222	18	42	12	51
1936	228	19	33	14	46
1937	240	19	33	15	52
1938	227	19	33	15	46
1939	231	19	34	16	47
1940	224	18	40	18	27
1941	206	19	47	20	9
1942	205	21	53	22	8
1943	199	21	50	23	8
1944	193	21	93	24	6
1945	183	21	102	24	8
1946	189	23	135*	26	9

* Estimated

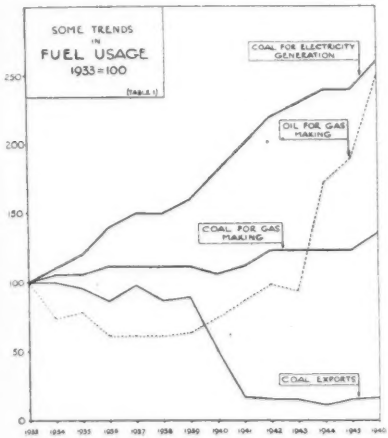


Fig. 1

To quite what extent oil consumption in the country would have risen if development had been unfettered is difficult to estimate. From 1933 to 1939, the total inland consumption of fuel oils (fuel, diesel, and gas oil) remained almost stationary at 1½ million tons per annum. During the war consumption rose to 2 million tons (including some home-produced substitutes) and, as a result of the Government's coal-to-oil conversion campaign, it was by the Spring of 1947 approaching the rate of 4 million tons a year. At the present time, there is scope for the economic use of a further 4 to 5 million tons of fuel oil a year, making a total of 8 to 9 million tons. This is a small quantity in comparison with Britain's average coal consumption of 190 million tons a year, but it could nevertheless make a major contribution towards bridging the gap between fuel requirements and coal production. The figure of 8 to 9 million tons does not allow for any development new to the country, e.g. diesel railway traction, gas turbines, etc., and covers only those existing applications where oil could be used at an overall thermal efficiency greater than that of the fuel it replaces. It is anticipated that many of the present unsound conversions to oil will revert, and indeed should revert, to coal at the earliest opportunity. Properly used, five million tons of oil could save considerably more than the eight million tons of coal a year envisaged by the Government.

FUEL ECONOMY EFFICIENCY

Fuel efficiency, when conceived in terms of conserving scarce resources, must always be related to the basic raw fuel, even though the fuel may be consumed in some derived form. The conception of "coal economy efficiency" has been used in the Egerton Report,* which demonstrates that some 27 per cent of the heat energy of the raw coal used at gas works is lost while 73 per cent is available to the consumers of gas, coke and other by-products. In the case of the public electricity supply,

* Post-war Building Study No. 19—Heating and Ventilation—H.M.S.O.

82 per cent of the heat in the coal is lost and the proportion available to the consumer is only 18 per cent.

Table II extends the conception of fuel economy efficiency to a number of familiar applications using different types of fuel. It demonstrates in a most marked manner the improved fuel economy to be obtained from changing the type of fuel for certain purposes and, moreover, it shows the benefit to the national economy of consuming fuel, wherever practicable, in its raw state, that is to say, eliminating transformation losses.

The desire for more accurate control, to reduce smoke, soot and ash-handling, to save labour and to improve atmospheric and working conditions, has resulted in an increasing tendency away from the burning of raw coal towards its cleaner controllable derivatives. These cannot, however, meet every type of requirement, while liquid petroleum fuels, used directly, can fulfil a large part of the demand for cleanliness and controllability with advantage to the national fuel economy.

An analysis of the examples in Table II according to their application is given in Tables III to IX, showing the fuel economy efficiency and the therms of fuel used for a given result. The diagrams are on the basis of an equal output of heat or energy. They show the total heat input necessary and, in black, the proportion of this which is wasted. Coal tar fuels have not been included since they are of more value for other purposes. Moreover, being derived from coal by two successive processes, each involving a transformation loss, they have a low fuel economy efficiency. Kerosine has been included where appropriate as, although it does not come within the category of "fuel oil", it demonstrates the remarkable difference in overall efficiency between oil and derivatives of coal.

TABLE III

Fuel Economy in Heating Individual Rooms

Individual room heating by	*Fuel economy efficiency* per cent	*Therms of fuel per* 100 *therms of useful heat*
1. KEROSINE flueless heater	93	107
2. ELECTRIC fire (topping up), electricity generated in composite power and heat plant (see also IV.5)	70	143
3. TOWN GAS in flueless heater	66	151
4. ANTHRACITE in closed stove	55	182
5. COAL in closeable fire, closed	48	
open	40	227
6. COKE in closeable fire, closed	39	
open	33	278
7. ELECTRIC fire, electricity generated from oil engine	32	312
8. TOWN GAS fire with flue..	29	344
9. COAL in open fire ..	20	500
10. ELECTRIC fire, electricity from public generating stations	18	555

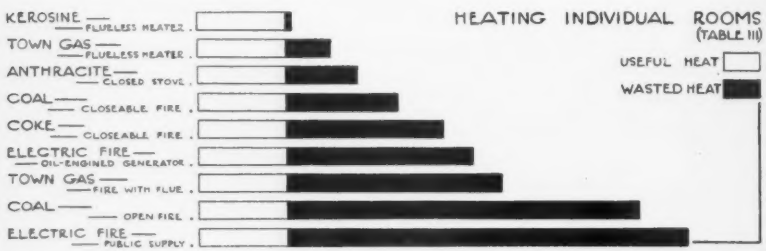
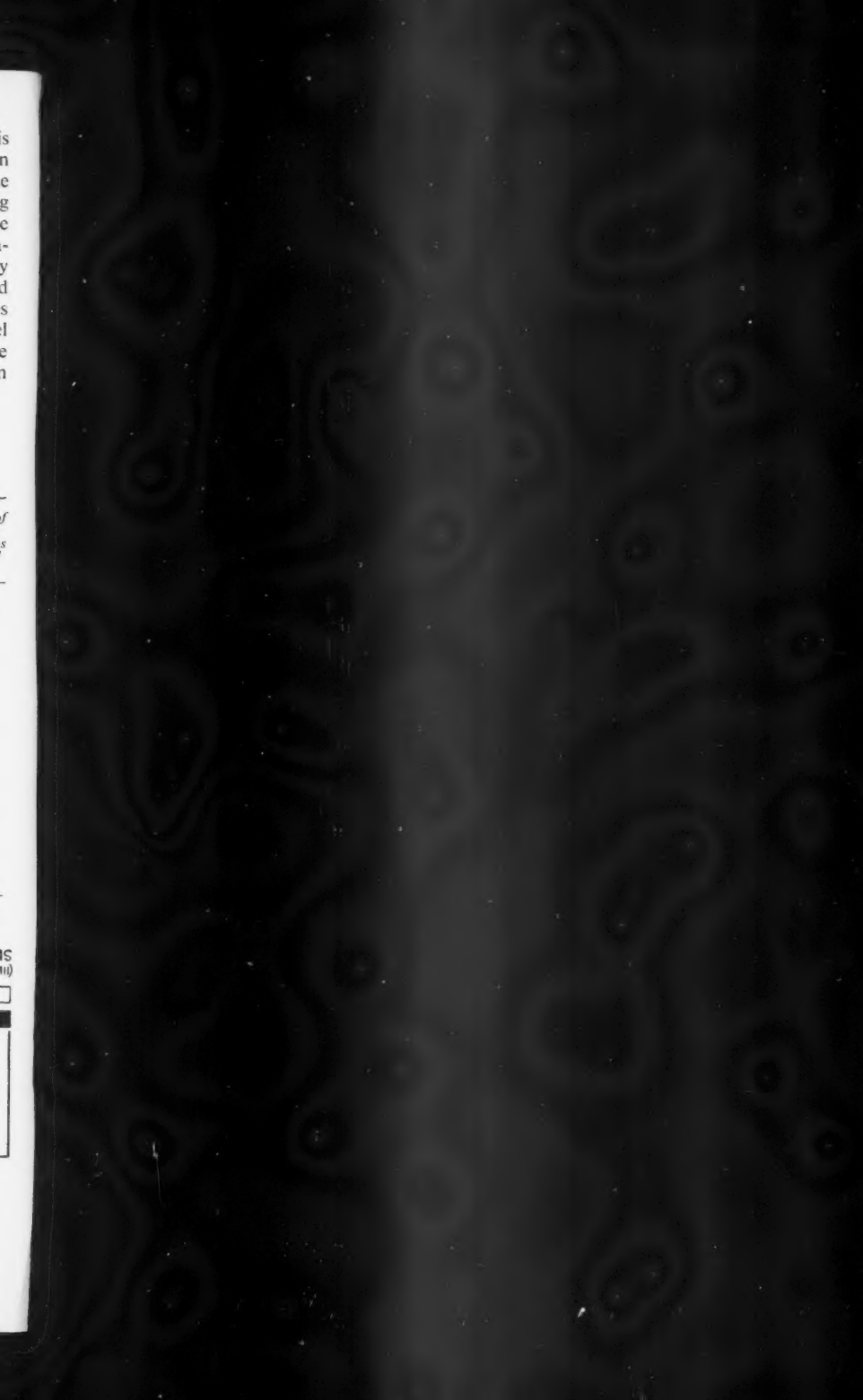


Fig. 2



TABLE

Fuel Economy Efficiency of Common Source

NOTES—

Column I denotes the fuel or energy in the form in which it is used. The
from coal or oil is given in column II. The production efficiency of both
in both cases power is consumed and there are coal losses in washing and clea
as such, which is mainly the case to-day, production losses occur in the co
Column IV is the working efficiency of the appliance, the figures in many ca
a distribution system, such as a domestic hot water or central heating syst
shown in Column V. The efficiency of a domestic hot water system for small
When an electric immersion heater is used in the storage cylinder, losses fro
increases the efficiency to 66 per cent.
Column VI is the percentage product of columns IV and V.
Column VII is the percentage product of columns II and VI and shows the u
heat in the basic raw fuel consumed.
Items marked with the same letter (A B C, etc.) are roughly comparable.

Fuel as Used (I)	*Efficiency of production* per cent (II)	*Eff* *Purposes and Method of* (III)
ANTHRACITE	100	Room heating, closed stove .. .. .. Central heating, automatic gravity feed boiler Central heating, hand-fired boiler with thermostati Central heating, hand-fired boiler .. .. Water heating, small independent boiler ..
COAL	100	Room heating, open fire .. .. .. Room heating, closeable fire, open .. .. closed .. .. Central heating, mechanical stoker .. .. Steam raising, large water-tube boiler, pulverized f Steam raising, shell boilers, hand-fired .. Railway traction, coal-fired steam locomotives
COKE	73	Room heating, closeable fire, open .. .. closed .. .. Central heating, automatic gravity feed boiler Central heating, hand-fired boiler with thermostati Central heating, hand-fired boiler .. .. Water heating, small independent boiler ..
ELECTRICITY from coal (public supply)	18	Room heating, electric fire .. .. .. Central heating, electrode boiler .. .. Water heating, immersion heater in cylinder Water heating, single point storage heater .. Industrial furnaces .. .. Railway traction, complete electrification ..
from oil engine	32	Room heating, electric fire .. .. .. Central heating, electrode boiler .. .. Water heating, immersion heater in cylinder Water heating, single point storage heater .. Industrial furnaces .. ..
from composite power and heat plant	70	Room heating (topping up), electric fire .. Room heating (background), central heating plant Industrial furnaces .. ..
PETROLEUM FUELS	100	Room heating, flueless kerosine heaters .. Central heating, specially designed automatic boile Central heating, normal sectional boiler, automatic Water heating, kerosine-fired circulator .. Water heating, single point storage heater (kerosin Steam raising, large water-tube boiler .. Steam raising, shell boilers, hand-controlled Industrial furnaces without recuperation (1400°C) Industrial furnaces, with recuperation (1400°C) Railway traction, oil-fired steam locomotives Railway traction, diesel-electric locomotives
PRODUCER GAS	80	Industrial furnaces without recuperation (1400°C) Industrial furnaces with recuperation (1400°C)
TOWN GAS	73	Room heating, flueless heater .. .. Room heating, gas fire.. .. .. .. Central heating, specially designed automatic boile Water heating, small boiler .. .. .. Water heating, single point unit heater Industrial furnaces without recuperation (1400°C) Industrial furnaces with recuperation (1400°C)

s of Heat in Various Applications

efficiency of the production processes involved in the transformation coal and oil has been taken as 100 per cent, though it is realized that ning and oil losses in refining. In so far as petroleum fuels are imported untry of origin and do not fall on Britain as consumer.
ses being taken from the Egerton Report. Where the appliance serves em, the percentage of heat arriving at the point where it is wanted is dwellings has been taken at 60 per cent for solid fuel, gas and kerosine. n flow and return pipes are eliminated and the appropriate adjustment

seful heat available at the point of consumption as a percentage of the

iciency of Utilization

Use	*Appliance efficiency* per cent (IV)	*Efficiency of heat transfer* per cent (V)	*Overall efficiency* per cent (VI)	*Fuel economy efficiency* per cent (VII)	
.. ..	55	100	55	55	A
.. ..	75	say, 90	68	68	B
t damper control	65	say, 90	59	59	B
.. ..	60	say, 90	54	54	B
.. ..	35	say, 60	21	21	C
.. ..	20	100	20	20	A
.. ..	40	100	40	40	A
.. ..	48	100	48	48	
.. ..	70	say, 90	63	63	B
uel	80	(100)	80	80	E
.. ..	65	(100)	65	65	F
.. ..	—	—	about 7	7	J
.. ..	45	100	45	33	A
.. ..	53	100	53	39	
.. ..	70	say, 90	63	46	B
t damper control	60	say, 90	54	39	B
.. ..	50	say, 90	45	33	B
.. ..	35	say, 60	21	15	C
.. ..	100	100	100	18	A
.. ..	98	say, 90	88	16	B
.. ..	100	say, 66	66	12	C
.. ..	90	(100)	90	16	D
.. ..	—	—	say, 70	13	G
.. ..	—	—	say, 80	15	J
.. ..	100	100	100	32	A
.. ..	98	say, 90	88	28	B
.. ..	100	say, 66	66	21	C
.. ..	90	(100)	90	29	D
.. ..	—	—	say, 70	22	G
.. ..	100	100	100	70	A
vith hot water circulation ..	100	say, 90	90	63	B
.. ..	—	—	say, 70	49	G
.. ..	93	100	93	93	A
.. ..	80	say, 90	72	72	B
control	75	say, 90	68	68	B
.. ..	80	say, 60	48	48	C
.. ..	75	(100)	75	75	D
.. ..	80	(100)	80	80	E
.. ..	70	(100)	70	70	F
.. ..	—	—	say, 34	34	H
.. ..	—	—	say, 64	64	G
.. ..	—	—	about 7½	7½	J
.. ..	—	—	say, 30	30	J
.. ..	—	—	say, 22	18	H
.. ..	—	—	say, 57	46	G
.. ..	90	100	90	66	A
.. ..	40	100	40	29	A
.. ..	85	say, 90	77	56	B
.. ..	80	say, 60	48	35	C
.. ..	75	(100)	75	55	D
.. ..	—	—	say, 30	22	H
.. ..	—	—	say, 60	44	G

DOMESTIC HEATING

Not all methods of heating individual rooms shown in Table III and Fig. 2 are suitable for continuous use—flueless heaters for example. Thus, Nos. 4 and 5, using solid fuel, would appear to be the best methods of carrying the main heating load. Other than for intermittent heating, for which they are very convenient, it is obvious that the use of electricity and gas is very extravagant in coal. The table also shows that, to obtain the same amount of heat, the country dweller, who has no gas or electricity and uses kerosine, requires only one-fifth the number of therms consumed by the town dweller using an electric fire. An interesting account of heating methods in the U.S.A. is given in *Domestic Heating in America* (H.M.S.O., 1946), and it is significant that there the electrical heating of houses and other buildings is virtually unknown, although the general standard of heating is much better than it is in Great Britain.

For continuous space heating, Table IV and Fig. 3 clearly demonstrate the higher efficiency of the central heating method over the method of heating rooms individually (Table III); the efficiency of the former is about half as much again. Table IV also underlines the advantage of consuming fuel in its raw state and the considerable reduction in overall efficiency involved in using gas and electricity, particularly the latter, for central heating. In general the demands of a space heating load are greatest—as in a period of cold wintry weather—at the very time when public gas and electricity services are least able to meet them, and are a major contributory cause of excessive peak loads. Solid fuel is thus the more

TABLE IV

Fuel Economy in Central Heating

Central heating by	*Fuel economy efficiency* per cent	*Therms of fuel per 100 therms of useful heat*
1. FUEL OIL in specially designed automatic boiler	72	139
2. ANTHRACITE in automatic gravity feed boiler ..	68	147
3. FUEL OIL in normal sectional boiler, automatically controlled ..	68	147
4. COAL with mechanical stoker	63	159
5. COMPOSITE POWER AND HEAT PLANT (see also III.2)	63	159
6. ANTHRACITE in hand-fired boiler with thermostatic damper control ..	59	169
7. TOWN GAS in specially designed automatic boiler	56	178
8. ANTHRACITE in hand-fired boiler	54	185
9. COKE in automatic gravity feed boiler	46	217
10. COKE in hand-fired boiler with thermostatic damper control	39	256
11. COKE in hand-fired boiler	33	303
12. ELECTRICITY in electrode boiler, generation from oil engine	28	256
13. ELECTRICITY in electrode boiler, supply from public generating stations	16	625

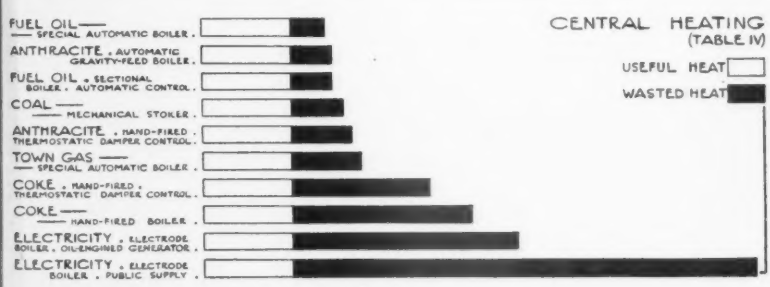

FUEL OIL— — SPECIAL AUTOMATIC BOILER .
ANTHRACITE . AUTOMATIC GRAVITY-FEED BOILER .
FUEL OIL . SECTIONAL BOILER . AUTOMATIC CONTROL .
COAL — — MECHANICAL STOKER .
ANTHRACITE . HAND-FIRED . THERMOSTATIC DAMPER CONTROL .
TOWN GAS — — SPECIAL AUTOMATIC BOILER .
COKE . HAND-FIRED . THERMOSTATIC DAMPER CONTROL .
COKE — — HAND-FIRED BOILER .
ELECTRICITY . ELECTRODE BOILER . OIL-ENGINED GENERATOR .
ELECTRICITY . ELECTRODE BOILER . PUBLIC SUPPLY .
CENTRAL HEATING (TABLE IV)
USEFUL HEAT
WASTED HEAT

Fig. 3

suitable fuel for general application, but in particular cases or districts, such as the built-up areas of cities, where the amenities inherent in a fluid fuel, e.g., rapid delivery, convenience in handling by pipe, cleanliness in use and absence of smoke, ash and clinker, are desirable, oil is the appropriate alternative if fuel economy is to be maintained.

The composite power and heat plant, where its use is practicable, deserves special mention since it facilitates the generation of electricity at a high efficiency and is the only instance where the use of electricity for space

TABLE V

Fuel Economy in Domestic Hot Water Systems

Hot water system heated by	*Fuel economy efficiency* per cent	*Therms of fuel per 100 therms of useful heat*
1. KEROSINE circulator ..	48	208
2. TOWN GAS circulator or small boiler	35	286
3. ANTHRACITE in small independent boiler ..	21	476
4. ELECTRIC immersion heater generation from oil engines	21	476
5. COKE in small independent boiler	15	667
6. ELECTRIC immersion heater supply from public generating stations ..	12	833

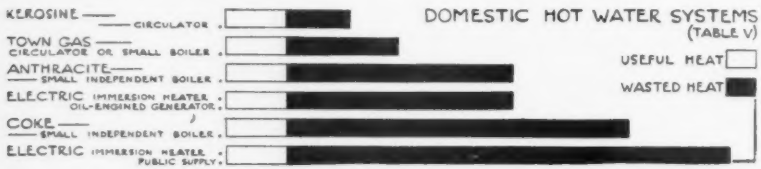

KEROSINE — CIRCULATOR
TOWN GAS — CIRCULATOR OR SMALL BOILER
ANTHRACITE — SMALL INDEPENDENT BOILER
ELECTRIC IMMERSION HEATER OIL-ENGINED GENERATOR
COKE — SMALL INDEPENDENT BOILER
ELECTRIC IMMERSION HEATER PUBLIC SUPPLY
DOMESTIC HOT WATER SYSTEMS (TABLE V)
USEFUL HEAT
WASTED HEAT

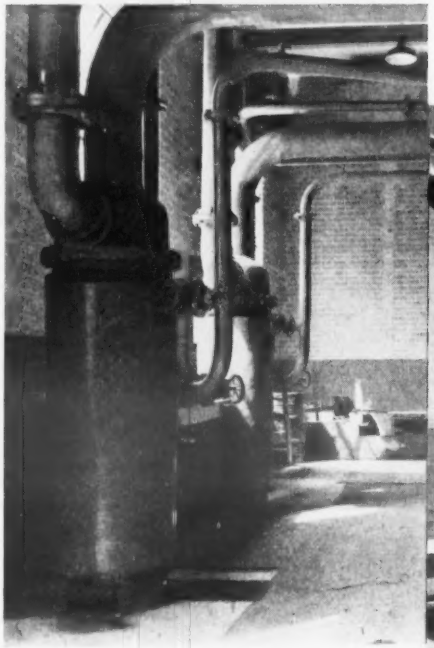
Fig. 4

heating purposes is really justified from the fuel economy standpoint (see No. 2 in Table III and No. 5 in Table IV).

That these considerations are to some extent appreciated is shown by the interest now being taken in district heating. At the present time, however, such schemes must be considered experimental, but the concentrated heat demand of city blocks—as distinct from individual buildings—offers considerable scope for efficient centralized heating methods and is a type of project which is already well proved. Not a few proposals of this type would be admirably suited to the joint production of electricity and heat by means of a composite plant. On grounds of amenity alone, oil fuel is an appropriate choice for many of the rebuilding schemes necessary in our large cities.

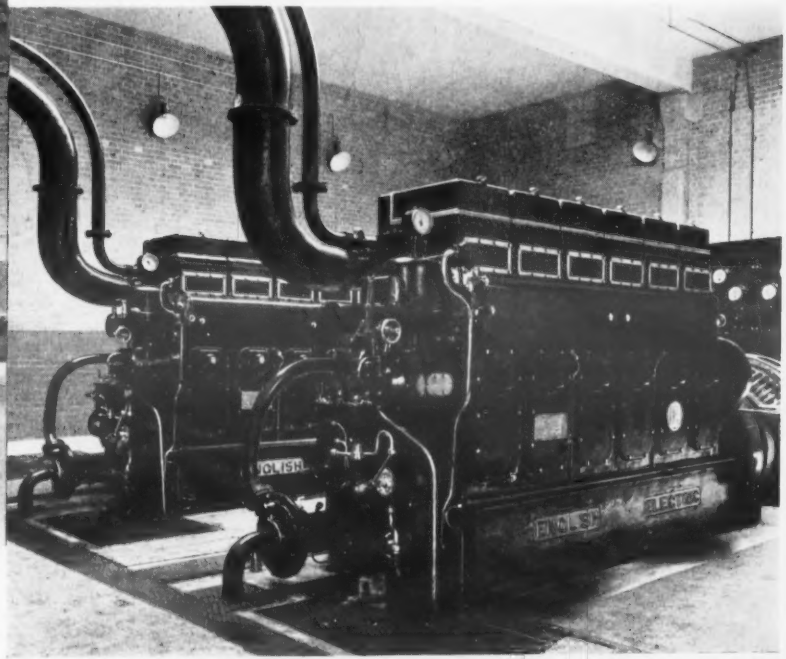
Table V and Fig. 4 are concerned with the normal domestic hot water system found in small dwellings. As a method of heating water, this type of installation is of a very low level of overall efficiency due to high losses. However, a substantial part of such losses contributes adventitiously to the space heating of the dwelling, which with our present methods of heating small dwellings is probably an advantage other than in very hot weather. In this case the table shows that kerosine and town gas are considerably more efficient than solid fuels, due to the higher efficiency of the appliances and their greater controllability.

To make comparison with Table VI more accurate, the hot water system selected as a basis for Table V (see Table II and accompanying notes) has an assumed heat transfer efficiency of 60 per cent for solid fuel, gas and kerosine, and of 66 per cent for electricity, which is, in fact, a very favourable one—the average pre-war installation would be more like 20 per cent efficient—and has been deliberately chosen so



COMPOSITE POWER AND HEAT PLANT

Diesel engines for electricity generation with waste heat boilers for process water installed in a leather works in the Midlands



[Courtesy of "The Oil Engine and Gas Turbine"

TABLE VI

Fuel Economy of Single Point Unit Heaters for Domestic Hot Water

	Fuel economy efficiency per cent	*Therms of fuel per 100 therms of useful heat*
1. KEROSINE in single point storage heater ..	75	133
2. TOWN GAS in single point unit heater	55	182
3. ELECTRIC single point storage heater, generation from oil engine ..	29	344
4. ELECTRIC single point storage heater, supply from public generating stations	16	625

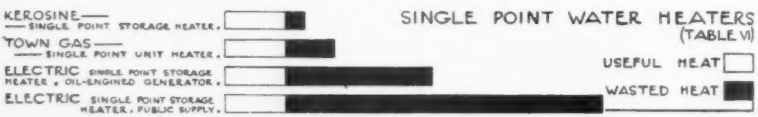

KEROSINE — SINGLE POINT STORAGE HEATER.
TOWN GAS — SINGLE POINT UNIT HEATER.
ELECTRIC SINGLE POINT STORAGE HEATER. OIL-ENGINED GENERATOR.
ELECTRIC SINGLE POINT STORAGE HEATER. PUBLIC SUPPLY.
SINGLE POINT WATER HEATERS (TABLE VI)
USEFUL HEAT
WASTED HEAT

Fig. 5

that the ancillary space heating effect is at a minimum. In Table VI and Fig. 5 the efficiency of single point unit heaters, from which there is little or no space heating effect, is compared. Again, kerosine and town gas have a higher efficiency than electricity, but the important feature is the considerably higher level of efficiency of this form of water heating compared with that in Table V, indicating one way of greatly reducing the fuel now consumed in providing domestic hot water. Though the two tables are not perhaps strictly comparable, the difference in efficiency between the two methods is sufficiently wide to justify this suggestion. Furthermore, if the Egerton recommendations are to be the generally accepted means of heating dwellings (i.e., even heating of the entire dwelling to a "background" temperature of 50 to 55°F with local topping up as desired) the additional uncontrolled space heating derived from the present type of domestic hot water supply system is probably undesirable.

INDUSTRIAL PROCESSES

To turn now to the industrial field, in which the scope for liquid fuel is wider, Table VII and Fig. 6 show that in the case of steam-raising the use of fuel oil in place of coal offers little increase in efficiency—in other words, little saving of fuel—over the best results achieved with solid fuel. The use of fuel oil under steam-raising boilers should, therefore, be confined to those cases, such as dairies, laundries, breweries, tobacco, food and other factories, where cleanliness and flexibility are indispensable factors, or to such instances where, due to the proximity of a plant to an oil-importing

TABLE VII

Fuel Economy in Steam Raising

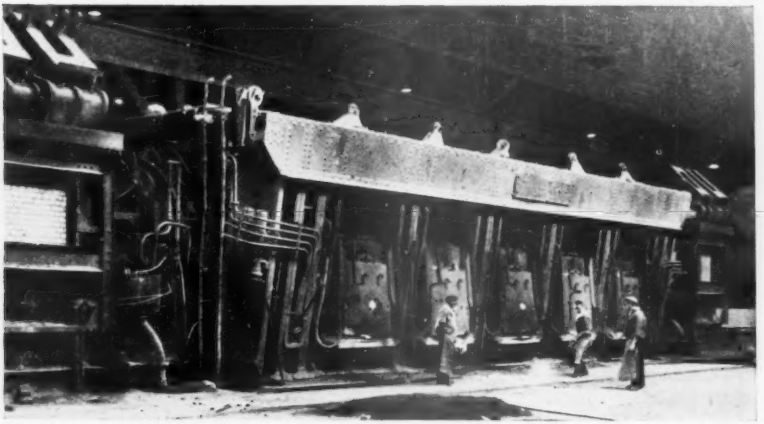
Steam raised by	*Fuel economy efficiency* per cent	*Therms of fuel per 100 therms of useful heat*
1. COAL in large water-tube boilers	80	125
2. FUEL OIL in large water-tube boilers	80	125
3. FUEL OIL, shell boilers hand-controlled ..	70	143
4. COAL, shell boilers hand-fired	65	154

COAL — LARGE WATER-TUBE BOILER.
FUEL OIL — LARGE WATER-TUBE BOILER.
FUEL OIL — SHELL BOILER. HAND-CONTROLLED.
COAL — SHELL BOILER. HAND-FIRED.
STEAM-RAISING (TABLE VII)
USEFUL HEAT
WASTED HEAT

Fig. 6

installation and its remoteness from a coal-field, the use of oil would be justified on the grounds of transport saving. There are many cases where neither of these considerations apply, and without doubt coal should continue to carry the bulk of the industrial steam-raising load. In addition to steam boilers there are certain other industrial processes, such as the manufacture of ordinary Portland cement, in which oil gives no thermal advantage over coal. The national interest demands that we should be just as strongly opposed to the wrongful use of oil as of any other fuel and, consequently, long term policy would be best served if such conversions were discouraged and efforts concentrated on improving the efficiency of existing coal-fired plant. It may for a time be necessary, however, since present coal production is insufficient for our needs, to use a certain amount of oil for thermally uneconomic applications in order to make good the deficiency. In this event, it should be recognized that the conversion of very large and already highly efficient boilers, such as those used at electric power stations, is a complicated, lengthy and expensive matter, and results in no real fuel economy. On the other hand, the ordinary industrial boiler plant of moderate size is the one most easily and quickly converted to oil, and may show a small fuel saving as well. Furthermore, the cases to be converted could be selected geographically so as to result in a concentration of oil-fired plants near those oil-importing installations which are remote from coal-fields. In this connexion, the London area would obviously be the most important.

The conclusions are very different in the next case to be considered—that of industrial furnaces, particularly those for high temperature processes. It is very difficult to express a genuine comparison in the form of a table, since the thermal efficiency of furnaces varies widely, from the order of 10 per cent and under for many forging furnaces to 70 per cent or so for modern melting furnaces. The figures chosen, while not purporting to represent the level of attainable efficiencies in a particular process, are roughly comparable. They are given in Table VIII and Fig. 7. Compared with producer gas, its nearest practicable competitor, fuel oil has a



A British open-hearth steel melting furnace recently converted to oil-firing

thermal efficiency at least 40 per cent higher. Although the calorific value of oil is but 1½ times that of average coal, there are, in fact, few processes in the iron and steel, glass, ceramics and metal trades generally in which one ton of oil will not do the work of two tons of coal and, commonly, enable a greater output to be obtained at the same time. The 16 million tons of coal used annually by these trades affords ample scope for the economic employment of oil. A further economy of great importance under scarcity conditions of manpower is that conversion to oil is often accompanied by a considerable saving of labour, both in operation and maintenance. This has been proved time and again in industrial applications.

In the steel industry the open-hearth furnace is a case deserving special mention. While coal must remain the basic fuel for blast furnaces, the use of producer gas on open-hearth melting furnaces in the U.S.A. has been virtually abandoned and oil fuel (in some cases natural gas) substituted. The thermal efficiency of American open-hearth furnaces is double that of their counterparts in South Wales and their rate of production is said to be 25 per cent higher. Quite apart from fuel economy, the possibility of higher production of steel would be an inestimable boon in to-day's conditions of acute shortage. Efforts are being made to rectify the position, and the British Iron and Steel Federation have stated that it is hoped, as a result of conversion, that the present annual rate of oil consumption of a quarter of a million tons will have been quadrupled by the end of the year. A remarkable achievement, and one which augurs well for the British steel industry, is the world's record weekly production from an oil-fired 100-ton open-hearth furnace recently set up in South Wales—and this in spite of less than eighteen months' experience of oil-firing. There is no doubt that the open-hearth steel furnace is one of the two outstanding cases in which neglect to take advantage of the technical advancement possible by the use of oil fuel has

TABLE VIII

Furnace fired by	*Fuel economy efficiency* per cent	*Therms of fuel per* 100 *therms of useful heat*
1. FUEL OIL, with recuperation (1400°C) ..	64	156
2. ELECTRICITY from composite power and heat plant	49	204
3. PRODUCER GAS, with recuperation (1400°C) ..	46	218
4. TOWN GAS, with recuperation (1400°C) ..	44	227
5. ELECTRICITY from oil engine	22	454
6. ELECTRICITY from public generating stations ..	13	770
1*a*. FUEL OIL, without recuperation (1400°C) ..	34	294
2*a*. TOWN GAS, without recuperation (1400°C) ..	22	454
3*a*. PRODUCER GAS, without recuperation (1400°C)	18	555

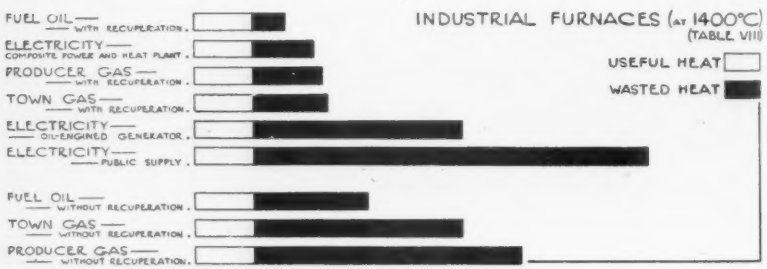

INDUSTRIAL FURNACES (AT 1400°C)
(TABLE VIII)
USEFUL HEAT
WASTED HEAT
FUEL OIL — WITH RECUPERATION.
ELECTRICITY — COMPOSITE POWER AND HEAT PLANT.
PRODUCER GAS — WITH RECUPERATION.
TOWN GAS — WITH RECUPERATION.
ELECTRICITY — OIL-ENGINED GENERATOR.
ELECTRICITY — PUBLIC SUPPLY.
FUEL OIL — WITHOUT RECUPERATION.
TOWN GAS — WITHOUT RECUPERATION.
PRODUCER GAS — WITHOUT RECUPERATION.

Fig. 7

put British practice generally ten years behind that of America. It is to be hoped that the Government will allow no obstacle, particularly in the matter of oil supplies, to hinder this most important development in the steel industry.

The other case where Britain lags behind the U.S.A. so markedly is in railway traction, the efficiency figures for which are given in Table IX and Fig. 8. The very low thermal efficiency of a coal- or oil-fired steam locomotive should be a matter of concern to a nation in which fuel economy is of so great importance, particularly when it is realized that the railway locomotives of Britain consume at least 13 million tons of coal a year. The table does not, in fact, tell the whole story, for shunting locomotives may operate at efficiencies in the order of 2 to 3 per cent. The present very large programme of steam locomotive conversion to oil has been adopted in order to reduce the demand for coal, but such a step is against the trend of development in other parts of the world and should be looked upon as a temporary expedient. As with stationary boilers, the conversion of a coal-fired locomotive to oil improves the thermal efficiency, and thus reduces fuel consumption (in therms), only slightly. It is true that there are other important advantages which the railway authorities in Great Britain have been quick to acknowledge now they have had some experience, but from the all-important view of thermal saving, the diesel locomotive under the most adverse conditions of comparison can be relied on to perform five times the work on one ton of oil that the coal-fired unit does on a ton of coal. In the case of shunting locomotives, L.M.S. experience over many years gives a ratio of 1 ton of oil to 12 tons of coal.

The western hemisphere has the experience of a long period of experiment and trial on which we could draw. There that stage is now virtually over, and current enquiries to American builders are all for diesel locomotives; practically no steam locomotives are

[Courtesy of English Electric Co. Ltd.

A 350-h.p. diesel-electric shunting locomotive as used by the L.M.S. Railway Co.

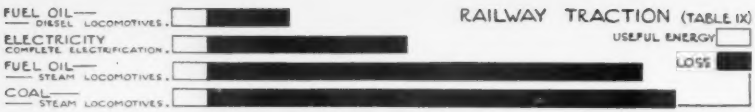


Fig. 8

TABLE IX

Fuel Economy in Railway Traction

Railway traction by	*Fuel economy efficiency per cent*	*Therms of fuel used per 100 therms converted into energy*
1. FUEL OIL, diesel locomotives	30	333
2. ELECTRICITY, complete electrification	15	667
3. FUEL OIL, steam locomotives	7½	1333
4. COAL, steam locomotives	7	1428

now being built for the U.S. railways. This is a revolution in railway traction from the benefits of which we have been almost entirely excluded, for there is not yet a single main line diesel locomotive operating on the British railways, although it is understood a few have recently been ordered. There is no doubt that the use of diesel traction on a substantial scale would enable the railways to be run on very much less fuel and with fewer locomotives, and incidentally, to make an important contribution to the elimination of smoke from the atmosphere.

There are certain other present-day trends which call for comment:

(1) *Gas making.* The use of oil for the manufacture of carburetted water gas is a useful adjunct to the normal gas works process and provides a convenient method of meeting peak demands. At present, however, it is being encouraged beyond the economic limit by a subsidy and, furthermore, large quantities of oil are likely to be used for direct gasification in horizontal retorts. The present high consumption of gas oil, shown in Table I, is four times the pre-war figure and two-and-a-half times that obtaining before the fuel oil tax was instituted. This increased consumption should be regarded as a strictly temporary means of augmenting coal gas supplies, since overall thermal economy is low and a better return can be obtained from the oil by using it directly and eliminating the transformation loss (25 to 40 per cent) of converting it into gas.

(2) *Generation of power.* The heavy oil engine—a largely British development—is thermally the most efficient of all commercial prime movers, even in quite small units, but only for marine purposes and for road vehicles and tractors has its development really gone ahead in Britain. There is probably a good case for the use of oil-engined generators in electricity generating stations, in particular for peak load duties—the coal-to-oil parity by weight is in the order of 2 to 1, or higher. Furthermore, industry and the country would benefit greatly from a policy facilitating the generation of electricity on the consumer's premises as a permanent feature of the country's power supplies, and it is encouraging to note the steps now being taken by the Government towards this end. Capital expenditure on the scale envisaged, however, will be largely wasted unless the engines are of a type which will give satisfactory service for at least fifteen years. Stand-by connexion to the grid would eliminate the need for the consumer to install duplicate equipment.

An important consideration—and one which must be uppermost in many people's minds to-day—is the assurance given by a fuel stocked on the premises as a means of guarding against the

breakdown of public supplies. No responsible engineer would erect an installation of an essential character without some security of this kind—one need only mention the B.B.C. The Corporation normally draws its power supplies from the grid, but its stations are equipped with oil-engined generators on a substantial scale, although apparently even in the acute emergency period early this year they were not, and are still not, being used to any great extent.

[Courtesy of "Diesel Railway Traction"

Two American diesel-electric passenger units, each of 2,000 h.p., undergoing tests in Eastern Pennsylvania prior to taking up service with the Santa Fe Railroad

It must always be remembered that ordinarily in any commercial method of converting fuel into mechanical energy—even the relatively efficient oil engine—more fuel is wasted than is effectively used (Fig. 9). The heat dissipated in the cylinder cooling water and exhaust from an oil engine, however, can largely be recovered and put to some useful purpose. In practice the amount recoverable represents some 40 per cent of the heat content of the original fuel. When fuel economy is paramount, it should be a first consideration to fit all oil engines, wherever practicable, with waste heat boilers. There must be many factories where the installation of diesel generators is contemplated which are already consumers of coal for providing hot water for one purpose or another, either for process work, space heating, or for canteens and lavatories, and some or all of this could be provided from the engines without consuming any extra fuel. Where this surplus heat can be recovered and used, the coal to oil parity by weight should be at least 3 : 1 and the overall efficiency of the plant in the order of 70 per cent. The Bank of England is one of these all too rare instances of a

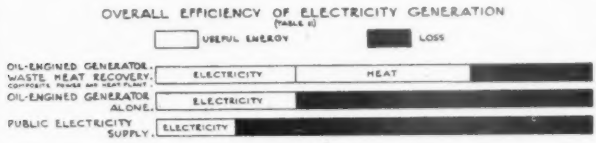


Fig. 9

composite power and heat plant, with auxiliary boilers, completely independent of outside aid other than fuel supplies, and with storage adequate to meet emergencies. The plant has a remarkably high overall efficiency, generating electricity and providing all the heat required on a fuel consumption probably lower than anywhere else in Britain.

CONCLUSION

The developments outlined above are aimed at using all our fuel resources to the best advantage and enabling as much coal as possible to be released to ease restrictions and, of course, for export. It is realized that the belief that Britain *must* be a "one-fuel" country is deeply ingrained and not quickly eradicated, but the truth is that under to-day's fundamentally changed conditions such a tenet is indefensible.

The ever-increasing use of controllable fuels, i.e., oil, gas and electricity, is a development to be encouraged—but not at the expense of national economy. Man has at his disposal two mineral fuels, coal and oil, of which only the *liquid* fuel is able adequately to meet the growing and insistent demands of certain branches of industry for flexibility and precision of control without large sacrifices in thermal economy. Its use should increase up to the economic limit, and will do so unless prevented by fiscal measures or governmental policy. Such an increase would be an invaluable aid in raising technical efficiency and an essential tool in competitive international trade, remembering always that to import oil and use it appropriately—and if necessary export the coal it releases—is to narrow the gap between us and our more advanced competitors.

Better Results from Less Fuel—Summary of Recommendations

(1) *In order to reduce the demand for gas and electricity for domestic heating next winter and to secure an overall fuel saving, the restrictions on the use of solid and liquid fuel in central heating plants should be removed;*

(2) *To help relieve the immediate difficulties of the public electricity supply, it should be made possible for all existing stationary oil engines that can be brought into regular use to operate to the fullest extent;*

(3) *In order to release oil for technically sound developments:*

(a) *those wasteful oil-burning schemes which have arisen during the present emergency, if they cannot be cancelled, should revert to coal at the earliest possible moment;*

(b) *the oil-firing of steam locomotives for railway traction and of large, already efficient, steam boiler plants should be discouraged; and*

(c) *the use of gas oil for gas making should not be stimulated beyond the economic limit;*

(4) *To make the best use of available oil supplies:*

(a) *the use of oil in open-hearth steel furnaces in particular and in the glass, ceramic and metal trades generally, should be expanded to the fullest practicable extent—great advantages, both to the industries and to the country, will accrue from these developments;*

(b) *the use of diesel locomotives on the railways should be vigorously encouraged; and*

(c) *the policy of installing diesel generators in factories should also include the conversion of such plants into composite power and heat units, and be extended to large buildings and blocks of buildings;*

(5) *To ensure the best use of Britain's coal resources, steps should be taken to rectify the unbalanced and potentially dangerous development of gas and electricity, particularly the latter, for uneconomic types of heating;*

(6) *To ensure the best use of* all *Britain's fuel resources:*

(a) *fuel efficiency in all its forms should be more actively encouraged and in such a way that the most efficient concerns are not penalized;*

(b) *all discriminatory tariffs and subsidies encouraging the wrong selection, and therefore wasteful use, of fuels should be discontinued—consumers should be able to make a comparison between the* true *costs of different fuels; and*

(c) *no further applications involving the thermally uneconomic use of oil should be authorized by the Government unless there are important technical advantages or amenities to be gained;*

(7) *To encourage technically sound conversions to oil and the accompanying capital expenditure, an official public statement that the fuel oil tax will not be re-imposed within the foreseeable future should be made.*

A. Gallenkamp & Co. Ltd. have just issued their catalogue No. 508 "*Gallenkamp*" *Specialities* devoted to laboratory apparatus. The last edition made its appearance in 1939.

U.K. OIL PRODUCTION

Production of crude petroleum by the Anglo-Iranian Oil Co. Ltd., from oilfields in the United Kingdom during 1946 was 55,387 tons, a decrease of 16,155 tons from the 1945 total of 71,542 tons.

WORLD PETROLEUM CONGRESS

The Permanent Council of the World Petroleum Congress met in London on July 21, 1947, for the first time since the war, under the Presidency of Colonel L. Pineau.

There were present Lt.-Col. S. J. M. Auld, T. Dewhurst, Dr G. Egloff, P. Erculisse, G. Filhol, Xavier Normand, and H. C. Tett. Professor H. I. Waterman officially represented the Dutch Committee.

[*Photo by "Petroleum Times"*

Front row (l. to r.): *Prof H. I. Waterman (Holland); T. Dewhurst (Great Britain); Dr G. Egloff (U.S.A.); Col. L. Pineau (France); Lt.-Col. S. J. M. Auld, O.B.E., M.C. (Great Britain)*
Back Row: F. H. Coe (Secretary); X. Normand (France); Prof P. Erculisse (Belgium); H. C. Tett (Great Britain); J. Filhol (France).

The Council decided to co-opt new members in consequence of the events which have occurred since 1939.

The Council fixed 1950 as the date of the Third World Petroleum Congress.

The First Congress was held in London, and the Second in Paris, and Council expressed a preference to hold the Third Congress in the U.S.A.

Bulletin No. 313 of the National Supply Co. gives drawings, photographs, and specifications of various combinations of pressure pack well head equipment.

TANKER ROUTEING AND OPERATION

By C. A. SAMUELS*

For the purpose of discussing the many and varied factors which contribute to the provision of a tanker service as required by the oil industry no particular comment will be made on the manning, storing, or bunkering of vessels, although it must be appreciated that each of these headings contributes its own problems and has some bearing on the ship's operations and flexibility in service.

It is generally known among those interested in the petroleum industry that in most cases the major oil companies own tankers or operate tankers through subsidiary companies. These vessels form the bulk of the tanker tonnage in service to-day, and are, to a large extent, built for and engaged in the owning company's particular trade.

The vessels trade to all parts of the world at the beck and call of the marketing organization as circumstances and markets dictate. This does not mean that the voyaging is haphazard, but rather that a very close liaison with the oil stocks position ensures the most suitable vessel being programmed for any particular requirement. There are, of course, occasions when through an unexpected cause on one account or another a late change has to be made, and this alteration is likely to cause a re-arrangement of the sailing orders for a whole group of vessels.

There are also tankers built for specialized trades, e.g., whaling, molasses, etc., which from time to time find opportunities to carry cargoes of petroleum products. In addition there is a block of tanker tonnage belonging to owners quite independent of the oil groups and available for chartering for voyages or periods of time to whomsoever may be interested. To a great extent this tonnage is employed by the oil groups and forms a very useful cushion in the various loading programmes.

It is clear that the employment problems which face owners of this tonnage are not necessarily similar to those with which the oil companies contend.

Oil tankers at times find themselves carrying a very odd assortment of bulk cargoes in addition to the usual range of petroleum products. Such commodities as grain, fish oils, vegetable oils, creosote, molasses, and fresh water are not unusual and, broadly speaking, any commodity that can be made to flow can be carried, although the carrying of such commodities requires careful consideration by the owners in relation to previous and subsequent cargoes.

For the purpose of this review, however, consideration will be given only to the carriage of petroleum products in bulk. In this category vessels may be sub-divided, according to the class of product carried, into three groups:

(*a*) White oils (which include motor spirit, kerosine, white spirit and gas oil);
(*b*) Black oils (which include crude, fuel oil, and diesel oil, etc);
(*c*) Lubricating oils.

and in arranging a loading programme it is necessary to allocate the vessels in these groups, as each calls for special requirements and vessels are not interchangeable in operation. For instance, vessels carrying black oil grades cannot be cleaned for white oil grades without special treatment and the attendant delays.

During normal trading an oil tanker carries cargo one way only, that is to say, from the source of production to

* British Tanker Co. Ltd.

a refinery or from a refinery to a distributing point, and on the return passage is ballasted with water. It should be noted that all tanks are not ballasted, but only those necessary to give the vessel sufficient stability for the voyage in question and even this can be adjusted during the passage should weather conditions or other circumstances require. These tanks must be washed out and cleaned either before sailing or during the passage in order to arrive at loading terminal with clean ballast water. It is the usual practice to carry out tank washing at sea, discharging the tank washings as far from the coast as possible. In order to avoid pollution of coastal waters and beaches, strict regulations prohibit the discharge of dirty ballast water in almost all coastal waters, and it is the general practice not to discharge such ballast water within 50 miles of any coast. At some loading terminals provision is made for the discharge of dirty ballast water into slop tanks ashore—but it may be taken as the general practice for vessels to arrive at loading terminals with clean ballast water.

The size of the vessel to be employed in any particular trade will be governed by the depth of water in the approaches to the port and at the berth in the case of river and sea terminals—in addition when the berth is situated inside a dock or basin consideration will have to be given to the dimensions of the entrance or locks. Tank capacity available at shore installations is another factor which sometimes restricts tanker size.

The layout of the pipeline system, cargo valves and pumproom arrangements will determine the number of grades of cargo that can be carried with safety. The pipeline system will vary in complexity from the simple arrangement necessary to manipulate homogeneous cargoes to the most complicated layout essential in a lubricating oil trader to segregate the many small parcels of different grades usually carried.

A certain number, if not all the vessels, engaged in black oil trading will require to be fitted with heating coils in the cargo tanks to assist the handling of heavy grades of oils particularly during periods of cold weather.

Port Operations

As a result of the very short time vessels remain in port during normal loading and discharging, little maintenance and repair work can be carried out. In fact very little work can be carried out on board in port without first obtaining a gas-free certificate from a chemist. It is necessary, therefore, to arrange for regular periodical overhauls, boiler cleanings, and drydockings.

The problems of the vessels themselves having been resolved, some consideration must be given to port regulations at the various ports concerned. It must be remembered that every effort is made at both loading and discharging ports to handle the cargoes in the shortest time possible consistant with safety—the speedy turn round of tankers in port offsets to some extent the long ballast passages that inevitably form part of the vessels service.

Port regulations for low flash point cargoes at most ports are usually very stringent, and, generally speaking, no other operations are carried out on board concurrently with the loading and discharging of these grades. The actual loading and discharging times must depend on several factors, e.g., size of shore lines, capacity of pumps, number of grades to be handled, distance to pump to or from shore tanks, etc., but in most instances 12 to 48 hours is adequate for the purpose.

To complete the ship's business in port there are other matters, all of which require prompt attention. For example:

Ballasting or unballasting, as the case may be;

Arrange and ship bunkers, fresh water, stores, provisions and, in many cases, pay off the crew;

Open new Articles of Agreement for the ensuing voyage.

There are also the many Customs formalities which are attended to by the Master in conjunction with the ship's agents. It will be seen, therefore, that to effect the turn round of a tanker within two or three days, a considerable amount of preparation beforehand and team work during the course of the vessel's stay in port are necessary in order that all the ship's business can be completed during the short time available.

The Forward Programme

The broad outline of tanker operation having been considered, it is appropriate at this stage to digress somewhat in order that an appreciation may be obtained of the data necessary in the building up of a forward programme. In order to avoid complicating the issue unnecessarily, no account will be taken of the handling of special products or the particular requirements of special trades, but attention will be confined to the two main streams of traffic in respect of which ships have to be provided:

(*a*) From source of production to refinery;
(*b*) From refinery to distribution points.

Subject to the normal functioning of the refinery, no particular difficulty may be expected under section (*a*) to supply regular replenishments of crude oil, as sufficient shore tankage is usually available to provide the necessary flexibility.

The provision of vessels to satisfy the requirements under section (*b*) is, however, quite a different story. The field to be covered may be taken as world wide and the source of supply may be from one point or many. At frequent intervals detailed advices of the actual stock position for the various grades must be obtained from each individual area concerned together with the estimated offtake for a given period ahead. The storage tank facilities for each grade at every discharging point are already known and this will determine the grades and the frequency of replenishments necessary to maintain the area concerned.

It will be appreciated from the foregoing résumé that the task of collecting together all the necessary data and weaving it into a forward programme for three months ahead entails considerable patience and ingenuity. The very fact that the ordinary consumer in normal times is seldom if ever unable to obtain on request his various requirements is in itself a tribute to the success of the system adopted by those concerned in the transport of products in their various stages from the source of supply to the retailer.

At the same time it is apparent that such a programme is influenced by many unpredictable occurrences, and changes in loading orders and cargo requirements are frequently necessary and always bothersome. On the assumption, therefore, that the original programme made out represents the best possible arrangement of tonnage and cargoes, then it is no understatement to say that any changes bring with them most of the inconveniences, difficulties and improvisations necessary to fulfil the requirements.

In conclusion let it be said that the oil industry is so closely knit together in its various activities, most of which are dependent one upon the other, that it is difficult to take just one section—as has been attempted here—without introducing those concerned in other operations which have a bearing, though perhaps less direct, on the actual

employment of tankers. Similarly special grades of cargo and particular trades for vessels require individual consideration, and no attempt has been made to embrace them in this review, the sole purpose of which is to relate how the ordinary tanker fits into the pattern of the world's oil supply lines for the popular grades of oil used by a great number of people in many countries.

U.S. CARBON BLACK INDUSTRY

Total production of carbon black from natural gas and liquid hydrocarbons in the United States in 1946 was 1,244,421,000 lb, an increase of 18 per cent over the 1945 figure of 1,052,798,000 lb. Of the 1946 total, furnace processes contributed 625,312,000 lb and contact processes 619,109,000 lb. Natural gas consumption in 1946 was 478,349 million cu. ft., compared with 431,830 in 1945. Thus average yields increased from 2.32 lb per 1000 cu. ft. in 1945 to 2.44 lb in 1946.

Comparing 1946 with 1945, total sales were 24 per cent higher at 1,269,740,000 lb, including exports which rose from 173,773,000 lb in 1945 to 271,085,000 lb in 1946.

Sixty plants were in operation in 1946, a gain of one over 1945, and the U.S. Bureau of Mines reports that average value of carbon black at plants increased from 4.02 cents per pound in 1945 to 4.82 cents in 1946.

Engineering and Technical Qualifications is the title of a booklet recently issued by the Advisory Bureau for Research, 70, Victoria Street, London, S.W.1. The booklet deals mainly with the different technical qualifications and examinations, with information regarding some of the British learned societies.

OIL SEARCH IN NEW GUINEA AND AUSTRALIA

It is announced in the Australian *Chemical Engineering & Mining Review* that the search for oil in New Guinea is to be intensified. The well at Kariava, shut down in January, 1942, at 5400 feet has been deepened to 6930 feet. Two more drilling rigs have been ordered and geophysical methods are to be employed. It is possible that an air-borne magnetometer may be used over thickly wooded areas.

The same journal reports that oil-prospecting programmes have recently been announced for the following areas in Australia: *South Australia, New South Wales and Queensland*: about 100,000 sq. miles north of Lake Frome. *Northern Territory and Western Australia*: in vicinity of Bonaparte Gulf. *Western Australia*, about 133,000 sq. miles in Desert Artesian Basin and 33,000 sq. miles in North West Cape region. *Queensland*: approximately 60,000 sq. miles in Roma district.

INSTRUMENTS AND MEASUREMENTS CONFERENCE

During the Conference on Instruments and Measurements held in Stockholm, June 4–7, 1947, and attended by over 400 delegates from various countries, some 50 papers were read and discussed. There were five main subject groups: (1) Industrial spectroscopy—17 papers; (2) Testing of materials and mechanical measurements—8 papers; (3) Industrial control —9 papers, (4) Metrology—7 papers; (5) General and miscellaneous—9 papers.

All the papers are to be published and are expected to be ready in January 1948. Further particulars are obtainable from R. Edmunds, National Physical Laboratory, Teddington, Middlesex.

PERSONAL NOTES

T. G. Hunter, Ph.D., A.R.T.C., F.Inst.Pet., senior lecturer, Department of Chemical Engineering, chairman of the Faculty Board of Applied Science, and Tutor to Iranian Students, University of Birmingham, has been appointed to the Chair of Chemical Engineering, University of Sydney. This has just been founded and is the only University School of Chemical Engineering in Australia. He will also be administrative head of the Departments of Mining and Metallurgy, which are included in this School at present.

As research assistant to Prof J. S. S. Brame at the Royal Naval College, Greenwich, Dr Hunter carried out researches into the composition of cracked distillates and later worked for three years on the hydrogenation of coal for I.C.I. at Billingham-on-Tees. In collaboration with the late Prof A. W. Nash at Birmingham he carried out intensive researches on solvent extraction, dewaxing, and the manufacture of synthetic lubricants. He has been author or co-author of nearly 50 scientific papers, and is best known for work on solvent extraction and the application of triangular diagrams to chemical engineering design and calculations in this field, which have now become standard text-book methods.

T. C. G. Thorpe, F.Inst.Pet., has been appointed assistant manager of the technical sales department of Anglo-American Oil Co. Ltd., in succession to *E. W. Hardiman*, B.Sc., M.Inst.Pet., recently promoted to manager of motor oil department.

Major W. H. Cadman, M.B.E., F.Inst.Pet., has been elected a vice-president of the Royal Institution and also of the Royal Society of Arts.

V. M. Farrant, M.Inst.Pet., who recently joined the Ragosine Oil Co. Ltd., as sales manager (northern), was for a number of years with Manchester Oil Refinery Ltd. He was also Honorary Secretary of the Northern Branch of the Institute, but has now relinquished that post.

T. W. E. Dunkley, M.C., who has recently joined Manchester Oil Refinery Ltd., in charge of sales and distribution, joined the Vacuum Oil Co. Ltd., at the end of World War I, resigning in March 1940 to rejoin the army. He saw service in northern India, the North-West Frontier, and in Burma, and when demobilized held the rank of Lieutenant-Colonel.

A. H. Nissan, Ph.D., D.Sc., F.Inst.Pet., well-known for his work in the Department of Chemical Engineering, Birmingham University, and particularly for his investigations in the field of viscometry, is leaving the University. On October 1 he is joining the staff of the Bowater Paper Corporation Ltd., as head of the Headquarters Research Laboratories.

H. G. Shatwell, Ph.D., M.Sc., A.R.I.C., M.Inst.Pet., was a recent visitor to the office during a short period of leave from his work at the King Fuad 1st University, Cairo.

E. V. Murphree, executive vice-president of the Standard Oil Development Co., has been elected president of the company in succession to *Robert P. Russell*. Mr Murphree joined the Standard Oil Co. (New Jersey) in 1930, succeeded to the post of manager of research and development for the Development Co. in 1936, was appointed vice-president in 1938, and became executive vice-president in 1944. His many contributions to the company's technical developments include the fluid catalytic cracking process, the synthesis of toluene, and a catalytic process for making butadiene from petroleum. Mr Russell, who joined the Development Co. in 1927 and became its president in 1944, was the recipient of the Medal of Merit for outstanding service during the war, and the Medal of Freedom for conspicuous service in connexion with military operations in

a war theatre. He has resigned from the Development Co. to become technical consultant to International Basic Economy Corporation.

D. S. Robertson, manager of Asiatic Petroleum Co. (Straits Settlements) Ltd. (now Shell Petroleum Co. of Straits Settlements Ltd.) has been appointed a Member of the Order of the British Empire "for service to fellow internees in Sumatra during the enemy occupation".

T. A. Boyd, who has been elected president of the A.S.T.M. for 1947–48, is best known in the petroleum industry as the co-discoverer with Kettering and Midgley of the anti-knocking effects of liquid compounds of lead. Head of fuel research for General Motors Corporation, his chief subject has been knock—what it is and how to reduce it or eliminate it as a barrier to improved power and efficiency. From these researches have come important contributions to modern motor fuels and to aviation fuels.

Alexander Fraser, recently appointed president of Shell Union Oil Corporation, is a native of Scotland and joined the Shell organization shortly after World War I. During that war he was secretary of the Inter-Allied Petroleum Council.

George E. Bertram, who has recently retired from the York area managership of Anglo-American Oil Co. Ltd., after 52 years' service, joined the company at the age of 12½ as a messenger in the Hull office.

INDIAN OIL PRODUCTION

Total production and value of crude petroleum in India during 1944 was:

	Gallons	*Rs.*
Lakhimpur, Assam	82,296,025	1,40,52,781
Attock, Punjab	15,157,052	37,89,263
	97,453,077	1,78,42,044

according to the Report of the Director of the Geological Survey of India, contained in a news quarterly publication *Indian Minerals*, issued by the Mineral Information Bureau of the Survey.

This first issue, dated January 1947, also contains an article on "Petroleum in India", by J. Coates (*The Burmah Oil Co. (India Concessions) Ltd.*), and the second number is scheduled to include an article on "Geological Prospecting for Oil in India". The publication also contains news items, trade and commercial intelligence, metals and minerals prices, and other articles of interest. It is priced at Rs. 2 (3s.) per copy and is obtainable from the Manager of Publications, Civil Lines, Delhi.

NORTHERN BRANCH OFFICERS

The Annual General Meeting of the Northern Branch of the Institute of Petroleum was held in Manchester on May 20, when the following were elected by ballot as new members of the Committee: A. Featherstone, M. Mason, T. G. Provost, H. A. Ruffell.

In his Annual Report the chairman (G. H. Thornley) paid particular tribute to the educational work of E. S. Sellers in the organization of the petroleum technology course at the Manchester College of Technology. At the conclusion of the meeting a vote of thanks to the retiring chairman, G. H. Thornley, was carried unanimously with acclamation, as also were similar resolutions in regard to the work of V. M. Farrant as Hon. Secretary and E. R. Wilson as Hon. Treasurer.

At a subsequent meeting of the committee, E. J. Dunstan was appointed chairman, T. W. Ranson, deputy chairman, and Mervyn Mason as Hon. Secretary in succession to V. M. Farrant, who has resigned from that position.

Serving a World Market is the title of an attractive and informative brochure recently issued by the Filtrol Corporation.

COUNCIL COMMENTARY

PRIOR to the Special General Meeting of the Institute on July 24, a good gathering of the stalwarts among the Council members dealt with a full length agenda under jungle conditions of heat and moisture.

After the Minutes had been dealt with further matters included reports from various Committees, e.g., By-laws, Branches, Election, Housing, etc.

Further discussion on the Institute crest made it clear that this would not be ready in time to grace the forthcoming brochure describing the history and activity of the Institute, but opinion was unanimous that it would be better that the brochure should appear crestless than that this question should be rushed to a premature and probably unsatisfactory conclusion merely to keep a date. Doubtless, in due course, oil and art will contrive between them to smooth the craftsman's task and give us a crest worthy of the Institute.

The report of the By-laws Committee was by way of being a final one rounding off a long and arduous task of preparing revised By-laws which later in the day were accepted by the General Meeting. It is hoped that at least a modicum of readable English remains among the welter of necessary legal jargon and that in addition to being in conformity with the Articles of Association these revised By-laws will give unambiguous guidance in dealing with Institute affairs. This in particular applies to the position with regard to branches, a feature of Institute activity of growing importance which has not previously been adequately dealt with in the By-laws. In another way these impending By-laws cast their shadow on the discussion which centred around the recommendations of the Election Committee dealing with applications for membership. There will always be border-line cases but from now on grades of membership will have a clearer meaning, more logical and in the long run more satisfactory than in the past and achievement will carry suitable prestige irrespective of whether it is in the technical or non-technical fields of endeavour.

Matters concerning our expanded future home were reported by the House Committee, whilst Publication Committee were able to report that arrangements for meetings and papers to cover the next session were well advanced.

It was also reported that the occcasion of the visit to London of foreign delegates to the International Congress of Pure and Applied Chemistry just terminated had been utilized to assemble the Permanent Council of the World Petroleum Congress and to make tentative arrangements for the next Congress to be held in the United States of America in 1950. Preliminary moves in the way of establishing committees have already been made.

After some discussion of a possible publication by the Institute of results of research work and a few general matters, the Council retired to a well-earned tea before proceeding to the Special General Meeting in connexion with the revised by-laws.

STANDARD SAMPLES OF HYDROCARBONS

A total of 119 standard samples of hydrocarbons are now available from the U.S. National Bureau of Standards for the calibration of spectrometers used in the laboratories of the petroleum and allied industries. Details are available from the National Bureau of Standards, Washington 25, D.C., U.S.A.

ELEVENTH INTERNATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY

By C. M. CAWLEY*

WHEN it became generally known that the Eleventh International Congress of Pure and Applied Chemistry was to be held in London from July 17–24, 1947, there were some who prophesied its failure. In fact, it was a resounding success.

There were indeed many difficulties to be overcome, difficulties of a kind with which most of us are all too familiar to-day, difficulties of printing, catering, travelling, accommodation, and so on. All these obstacles were demolished by the faith and energy of the organizers, and any few imperfections which remained were swept aside by the torrent of goodwill which poured into London when the Congress opened.

At this world meeting of chemists, the first since the Rome Congress in 1938, twenty-seven nations were represented. Many of the leading figures in the chemical world were present, and rarely has London seen so distinguished a gathering of scientists.

It was a great and memorable occasion. It was a time for greeting old friends, and for making new ones. It was a time for re-affirming the belief in internationalism, which is an essential part of the scientist's make-up. This then was the outstanding result of the Congress; that its many delegates and members returned to their homes warmed by new friendships, and inspired by the faith that science will break down the barriers that divide the world.

A second result of great importance was the valuable contribution to chemistry made by the many papers (some 400 to 500 in number) presented to the Congress. These were distributed between the fourteen sections which dealt respectively with each of the branches of pure and applied chemistry. Section 9 was concerned with Chemistry in Relation to Fuel, Power and Transport, and with Section 13 on Chemical Engineering, will be of greatest value to petroleum technologists in general. Interest will, however, by no means be confined to these sections, since all the sections on branches of pure chemistry contain papers which bear on some aspect of petroleum technology. As examples in this connection may be cited the papers on the studies of Infra-Red Spectroscopy and the Mass Spectrometer contributed to Section 2 (Physical Chemistry).

Each Section had a President of Honour, a Chairman, and a Vice-Chairman, and these officers for Section 9 were Dr H. H. Lowry, Professor Sir Alfred Egerton, and Sir Ernest Smith. The Secretaries were Dr R. B. Randall and the author. The papers presented to the Section were arranged as contributions to form symposia on (1) "Liquid Fuels and Other Products from Petroleum and Coal", (2) "Characteristics of Solid Fuels", (3) "Carbonization and Gasification", and (4) "Combustion". Each symposium was introduced by an opening paper surveying the field, and included in addition some seven to fifteen papers, most of which were read and discussed, although, owing to the limitations of time, several most interesting papers could be read in title only.

In addition to these symposia, the programme of Section 9 included an Address by Sir Ernest Smith on "The Training of Chemists for the Fuel Industries". This topical subject initiated

* Fuel Research Station, Department of Scientific and Industrial Research.

a lively discussion, which was opened by Professor F. H. Garner and closed by Dr G. W. Himus.

Professor Garner gave the opening paper to the Symposium dealing with petroleum technology and allied subjects, and most of the oil companies contributed to the rich programme of papers which followed. These papers in particular will have a direct appeal to readers of the *I.P. Review*, and are therefore listed below in their entirety:

1. "Liquid Fuels and other Products from Petroleum and Coal", by F. H. Garner.
2. "The Fluid Solids Technique. Applications in the Petroleum Industry", by E. V. Murphree, E. H. Gohr, and A. F. Kaulakis.
3. "Production of Olefins from Mineral Oils", by C. Padovani.
4. "Developments in Technique in Fuel and Lubricants", by J. A. Oriel.
5. "The Properties of Hydrocarbon Fuels for Gas Turbines", by D. A. Howes and H. C. Rampton.
6. "The Chemistry of the Fischer-Tropsch Process", by S. R. Craxford.
7. "Petroleum and Coal as Source Materials for Chemical Derivatives", by Gustav Egloff.
8. "Coal-in-Oil Suspensions", by W. Idris Jones.
9. "The Properties of Tars and Bitumens in Relation to their Use in Road Construction", by A. R. Lee.
10. "The Oil Shale Deposits of the World and Recent Developments in their Exploitation", by W. H. Cadman.
11. "Ester Waxes from British Peat", by C. M. Cawley, J. H. G. Carlile, and C. C. Noaks.
12. "Chemical Interdependence of Agriculture and Petroleum", by Gustav Egloff.
13. "Catalytic Polymerization of Cracked Gases to Produce Motor Fuel", by Gustav Egloff and P. C. Weinert.
14. "Refining of South American Crudes (Thermal and Catalytic Cracking)", by Gustav Egloff and Davis Read.
15. "Alkylation of Paraffins by Olefins", by Gustav Egloff and George Hulla.
16. "Solvent Extraction of Indene and Coumarone from Coal Tar Light Oils", by A. W. Gauger and J. N. Breston.

The papers were read before a distinguished gathering of chemists and petroleum technologists, and the discussions which followed roved over a wide field, subjects of special interest being the application of the fluid solids technique, and the production of chemicals from petroleum.

The opening paper to the symposium on "Characteristics of Solid Fuels" was given by Dr A. Parker, who was followed by authors to a large extent concerned with the constitution of coal —a subject around which most of the discussion revolved.

The symposium on "Carbonization and Gasification" was opened by Dr J. G. King, and papers were presented on underground gasification, the removal of hydrogen sulphide from flue gases, the catalytic production of methane, coal carbonization, and several other subjects. The possibilities of the development of the technique of underground gasification attracted most attention in discussion.

The fourth and last symposium of Section 9 was on "Combustion". The opening paper here was presented by Professor D. T. A. Townend, and the papers which followed dealt with flame propagation, the combustion gas turbine, and the formation of deposits in boilers. All these subjects were referred to in discussion, but flame propagation was the foremost interest of most speakers.

Section 13 on Chemical Engineering, under the Chairmanship of Dr A. J. V. Underwood, also arranged a most attractive programme, which petroleum technologists will find of the greatest interest. While they will wish to refer to this programme in detail, attention may be drawn here to the following papers:

1. "The Production and Purification of Hydrogen by the Water Gas Catalytic Process", by A. T. Grisenthwaite.
2. "The Catalytic Removal of Organic Sulphur from Flue Gases", by J. H. G. Plant.

3. "Large-Scale Oxygen Production", by M. Ruhemann.
4. "Manufacture of Ethanol from Ethylene", by R. S. Aries.
5. "Developments in Batch Distillation and Pure Toluene Production", by W. J. Chadder and H. M. Spiers.
6. "Process Design of Catalytic Reactors", by R. H. Dodd.
7. "Corrosion Problems in the Petroleum Refining Industry, with Special Reference to Problems Experienced in operation of Solvent Extraction, Dewaxing, and Chemical Treatment Plants", by J. C. Wood-Mallock, E. S. Sellers and H. Kay.

The list of papers of interest to petroleum technologists, given in this short note, is by no means comprehensive. In evidence of this, it is necessary only to mention, for example, Section 11, which deals with Chemistry in Relation to Elastomers, Plastics, Glass and Ceramics. It is apparent that the Transactions, in which all the papers presented to Congress will be published, will be a valuable work of reference for many years to come.

THE QUALITY OF BRITISH PETROLEUM

By J. S. PARKER, M.A., B.Sc., F.Inst.Pet.

IN setting out to describe the quality of a crude oil one is immediately confronted with the difficulty that the meaning of the term quality is interpreted differently in accordance with the background of the reader. The producer, the refiner, and the salesman have their individual viewpoints on this question, but the non-technical reader might consider their descriptions too technical.

Taking the case of the refiner alone there are probably as many methods of recording the quality of crude oils as there are operating refineries. The analytical work is carried out to parallel the operations of the main plant. The results thus tend to be individual to the refinery concerned and to lose their value with the obsolescence of the plant.

A standard method (*U.S. Bur. Mines Bull.* 401, 1937) of crude oil analysis is in less general use. This method results in standard data, both physical and chemical, which enables any crude oil to be fitted into an empirical chemical classification and which facilitates the comparison of one crude oil with another or with a series of published results. The method has been worked out for this particular purpose.

The main features of the analysis which are also features on which the classification is based are what have been termed "Key Fractions". These key fractions give an indication of the chemical properties of the crude oil. Key fraction No. 1, the fraction distilling between 250° and 275°C at atmospheric pressure, gives an indication of the chemical properties of the atmospheric products. Key fraction No. 2, the fraction distilling between 275° and 300°C at 40 mm absolute pressure gives an indication of the chemical properties of the lubricating oils. According to the A.P.I. gravity of each key fraction the crude oil is empirically classified into paraffin, intermediate, or naphthene base for each key fraction. To this definition wax-free or wax-bearing is added as the case may be.

QUALITY BY STANDARD METHOD

Considering quality first of all from the standpoint of this standard method all British crude oil may be classified as follows:

	Key Fraction No. 1	No. 2	Base
Dalkeith	44·5	34·4	Paraffin (wax-bearing)
Hardstoft	45·8	34·8	Paraffin (wax-bearing)
Eakring	39·6	32·3	Intermediate-paraffin (wax-bearing)
Formby	39·2	32·3	Intermediate-paraffin (wax-bearing)
Kelham	35·6	25·0	Intermediate (wax-bearing)
Caunton	35·2	24·9	Intermediate (wax-bearing)

The results quoted for Dalkeith and Hardstoft are from the published records which do not indicate the sampling conditions. The other four are operating refinery results obtained on actual production from known oil zones.

The terms "paraffin base" and "naphthene base" do not mean that the crude oil consists wholly or even predominantly of paraffin or naphthene hydrocarbons. They are terms extensively used in the petroleum industry, which have been adopted and organized into this system. They give an indication of the relative content in the crude oils of what the petroleum industry loosely terms paraffins and naphthenes.

All British crude oils contain wax, and for practical purposes they can be separated into two distinct classes:

(1) Paraffin base—Dalkeith, Hardstoft, Eakring, and Formby

(2) Intermediate base—Kelham and Caunton

The paraffin base is what might be termed a scarce class. It includes certain crude oils from such fields as Pechelbronn (France), Pennsylvania and West Virginia (U.S.A.) and New Brunswick (Canada). The indication here is geologically old crude oil.

The intermediate base is a class in which there is a much wider representation from the world's oilfields. Again Pechelbronn parallels the Kelham and Caunton of British crude oils.

The first outline of the quality of British crude oils is thus that they are all wax-bearing, that the majority are low specific gravity, paraffin base oils and the minority medium specific gravity, intermediate base oils, that the majority are in a class which has limited representation from the world's crude oils and the minority are in a class which is more generally represented and that the crude oils are very similar to those produced at Pechelbronn.

QUALITY BY REFINERY METHOD

	Eakring	Formby	Kelham	Caunton
Sp. gr. at 60°F	0·869	0·851	0·889	0·873
Red. I. Visc. at 70°F, secs.	230	66	190	84
Pour Point (Upper) (I.P. 15/42), °F	10	—40(*b*)	—40(*b*)	—40
Wax (U.O.P. A46/40), per cent	8·9	3·7	6·6	9·8
Asphaltenes (I.P. 6/45), per cent	0·05	Nil	0·33	0·44
Sulphur, per cent	0·07	0·14	0·55	0·65
Acidity, MgKOH/g	0·04	0·05	0·05	0·04

(*b*) Below –40

The distinction between the two classes is again evident in the lower specific gravity of the paraffin base crudes and their lower asphaltene and sulphur contents. Formby crude contains a certain proportion of its sulphur content in the form of sulphuretted hydrogen which has probably been picked up in the course of its migration.

DISTILLATION PRODUCT YIELDS

	Eakring	Formby	Kelham	Caunton
	% by wt. on Water Free Crude			
Light benzine	13·7	8·4	5·6	8·1
White spirit	4·0	8·0	5·1	6·6
Kerosine	10·7	13·4	10·0	11·1
Gas oil	10·6	14·4	11·4	12·5
Lube A	10·6	13·7	11·4	12·2
B	5·0	4·7	4·6	6·1
C	6·6	7·7	7·6	7·3
D	14·0	7·9	12·0	11·6
(Total lubes)	(36·2)	(34·0)	(35·6)	(37·2)
Residue	23·0	20·3	30·5	22·6
Loss	1·8	1·5	1·8	1·9

These product percentages are all typical of this general waxy type of crude oil, a high percentage of residue, a good working percentage of lubricating distillates, a high gas oil content and a benzine content on the short side, comparatively. The product percentages on the four crude oils are all roughly similar, the major variation being at the front end.

The octane numbers (I.P. 44/46 (T)) of the benzines, which have a final boiling point of 150°C, are Eakring 53, Formby 63, Kelham 57, and Caunton 54.

The diesel indexes (I.P. 21/42) of the gas oil fractions which are, in this distillation, narrow cuts are Eakring 64, Formby 63, Kelham 49, and Caunton 54.

The viscosity indexes of the lube distillates, dewaxed but unrefined, together with their corresponding viscosities at 100°F in centistokes are:

	Eakring		*Formby*		*Kelham*		*Caunton*	
	V.I.	*cs*	*V.I.*	*cs*	*V.I.*	*cs*	*V.I.*	*cs*
Lube A	87	8·2	87	8·4	63	9·0	63	8·6
Lube B	70	18·9	84	17·5	36	22·9	43	22·7
Lube C	77	33·3	90	24·8	53	47·1	49	47·1
Lube D	75	83·4	90	57·7	42	120·0	45	108·2

The difference between the paraffin base and the intermediate base is again apparent in the viscosities for comparative temperature cuts and in the viscosity index range. Formby crude shows up as the most highly paraffinic.

The wax yields, as per cent by weight of the lube distillates, together with their melting point in °F (I.P. 76/44 (T)) are:

	Eakring		*Formby*		*Kelham*		*Caunton.*	
	%	M.p.	%	M.p.	%	M.p.	%	M.p.
Lube A	12	97	5	99	8	92	13	97
Lube B	28	118	11	113	10	117	17	115
Lube C	30	125	15	115	10	126	16	125
Lube D	20	135	16	114	7	135	13	136

A broader outline of the quality of British crude oils is obtainable from the refinery method results. The benzines are, as one would expect from the paraffinic nature of the crudes, on the low side as regards octane number. There is no marked difference between the crudes in this respect. For high-speed diesel engine work the Eakring and Formby gas oils are exceptionally good. The Kelham and Caunton gas oils are good. The indications are that the Eakring and Formby lubricating oils are high quality. The Kelham and Caunton lubricating oils are medium quality. The percentage of lubricating oils in all the crudes is economic. The indications are that all the waxes are of good quality and that the higher melting point grades are obtainable. The wax percentages are economic, trending in the case of Eakring to put an overload on dewaxing rotary filters.

QUALITY IN GENERAL TERMS

All the crude oils produced in Great Britain are of the same general type. They are wax-bearing, with wax percentages by weight on the crude oil varying from 4 to as high as 12 per cent. They contain roughly similar product percentages with a comparatively low straight motor spirit content, a high gas oil content, a high lubricating oil content for this type of crude oil and a high residue content.

The crude oils are geologically old crude oils, and it is probable that any future discoveries of crude oil in Great Britain will be of this same general wax-bearing type.

Within this general type there are two distinct qualities of crude oil. The major percentage of the crude oils are what the petroleum industry terms paraffin base. If fractions are distilled off under standard distillation conditions then the hydrocarbons distilling off within a specified temperature range will be of lower specific gravity than those from any other type of crude oil. The minor percentage are intermediate base. In this case the comparable fractions have specific gravities mid-way between those from the paraffin base and those from the naphthene base which have the highest specific gravities.

The paraffin base crude oils have low sulphur and asphaltene contents. From them, with the exception of straight run motor spirit, top quality products are obtainable. They are markedly suitable for the manufacture of high quality lubricating oils.

The intermediate base crude oils have a higher sulphur and asphaltene content. The products are of medium quality throughout the entire range.

Without the complications of customs duties, which place a premium on the manufacture of indigenous motor spirit and DERV, the majority of the crude oils would be of high value in their natural lubricating oil class.

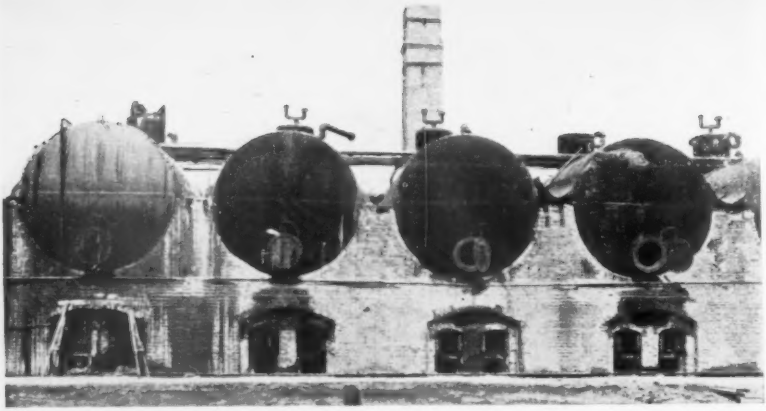


Photo by Arthur W. Eastlake

THEN AND NOW

Above, a battery of crude oil distillation stills in Louisiana 1915, and below, a modern vacuum still for crude oil distillation in the Amba refinery of the Lago Oil and Transport Co. Ltd.

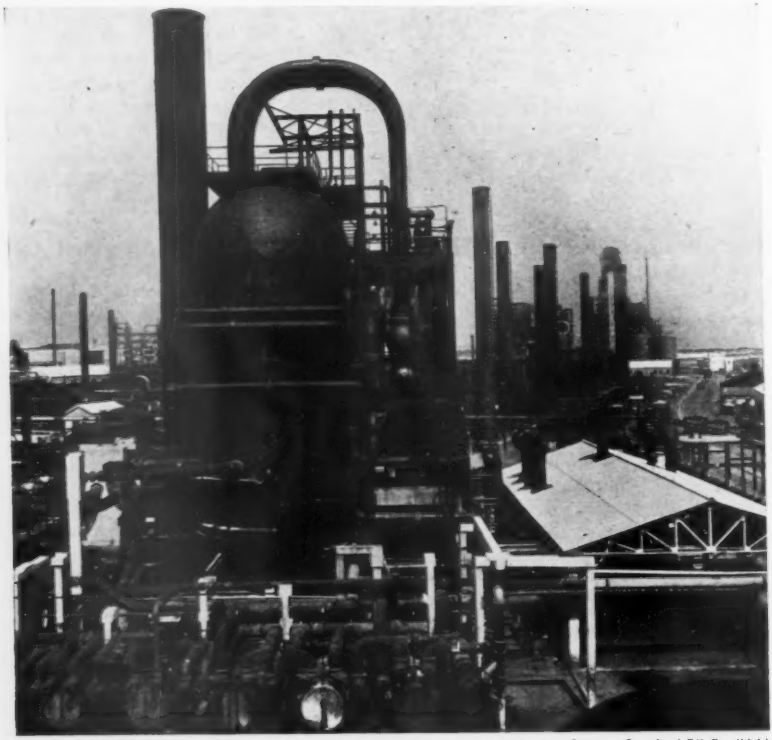


Photo by N. Morris] Courtesy Standard Oil Co. (N.J.)

FUEL OIL IN THE STEEL INDUSTRY

By T. C. BAILEY, F.Inst.F., M.Inst.Pet.

GREAT interest has been aroused by the rapidly growing use of oil in steel works, attention being mainly focused on its application to open-hearth melting furnaces. The results obtained have been remarkably successful, and have shown that fuel oil has definite technical advantages that can make a useful contribution to the national economy, not only by the resultant increased production of steel, but also by the saving of two or more tons of coal for every ton of oil burnt.

The initial production of steel in ingot form is of the greatest importance, but it must not be overlooked that other heat processes are required before the finished steel is ready for use, and many of these demand a fuel that can produce the "precision" heating conditions necessary to the particular process. Fuel oil is being successfully used for these finishing processes, and the author has, therefore, chosen three widely varying applications of oil to show its technical suitability in this field.

ROLLING MILL FURNACES

Rolling is the third process in the production of steel sheets or tinplate, the first process being the making of steel in ingot form and the second the rolling of the ingots into flat bars.* The latter are termed sheet or tinplate bars and are generally about eight inches wide and as long as the width of the sheets to be rolled; their thickness varies from half to one inch, depending on the length and thickness of the final sheet.

The sheet bars are heated in one furnace and are then passed through the rolls, first singly, and then in pairs. The furnace in which they are heated is known either as a sheet bar furnace or, more commonly, as a pair furnace. When the pairs have been rolled out to a certain length, they are doubled and reheated in a second furnace known as a sheet furnace. They are then rolled into their final length. When very thin sheets are to be rolled, the pairs are often redoubled, reheated and rerolled. After final rolling, the pack of sheets is opened and stripped apart.

The conditions required of the furnace and the fuel for this process are very stringent. They are:

(1) *Furnace atmosphere*

No loose scale must be formed on the sheets as it would spoil their appearance and affect the surface of the rolls; on the other hand, it is essential that a very thin layer of oxide is formed to prevent the bare metallic surfaces of the plates sticking together. This oxide must be very thin and even, so that it will stretch during the rolling without cracking. A theory has been advanced that the right kind of oxide can only be formed when water vapour is present in the products of combustion.

The fuel chosen must, therefore, be capable of producing the right atmosphere.

(2) *Furnace Temperature*

While the steel must be heated to a temperature at which it is sufficiently plastic to be rolled, it is important that it is not too hot when leaving the furnace, because it is exposed to the air for considerable periods during rolling and would scale excessively at high temperatures. It is important, therefore, that the temperatures of the sheets is kept down to the minimum required for satisfactory rolling.

* This applies to the production of sheet in the great majority of rolling mills in South Wales, Scotland and the Midlands. The production of the final sheet from the new continuous strip mills at Ebbw Vale, etc., is usually done in one process.

The bars and packs of sheets must also be very evenly heated throughout. If they are unevenly heated, there will be a tendency for the sheets to curl and become distorted.

The fuel chosen must, therefore, be one that can be accurately controlled so that the temperature of the furnace can be maintained within fine limits and one that can be burnt in a manner that lends itself to even heat distribution.

(3) *Cleanliness*

The desirability of keeping ashes and dust away from the sheets is obvious, as any abrasive matter will spoil the appearance of the sheets and be liable to damage the surface of the rolls.

A clean fuel must, therefore, be chosen for this process.

(4) *Labour Conditions*

In many works the team of operators handling the sheets and rolls are also responsible for the firing of the furnaces. The man-handling of bars and sheets is heavy and arduous work, and output of finished work is likely to suffer if the firing of the furnace also calls for heavy labour.

The fuel chosen must, therefore, be an "easy" fuel needing the minimum of attention from the operators.

Summarizing the requirements of this process, it seems that the fuel used must (*a*) be capable of producing and maintaining the correct furnace atmosphere; (*b*) be able to be controlled accurately (automatically if required); (*c*) be clean to handle and leave no ashes; and (*d*) be easily fired and regulated with a minimum of attention.

Fuel oil fulfils these requirements admirably, and results from five pairs of mill furnaces recently converted to oil in South Wales confirm that it is a most satisfactory fuel. Four of these furnaces were converted from direct coal-firing and one from anthracite producer gas. In each case, the sheet bar furnace and the sheet furnace are arranged as two separate compartments of one large furnace. Low pressure air burners are arranged to fire over the steel bars and sheets, which are in direct contact with the products of combustion from the oil.

Comparative results are given in Table I.

TABLE I

	Oil-fired furnace	*Producer Gas-fired furnace*	*Coal-fired furnace*
Raw fuel per box* of tinplate ..	8·4 lb	17 lb	22 lb
Therms per box* of tinplate ..	1·58	2·46	3·08
Therms of coal replaced by one therm of oil ..	—	1·56	1·95
Tons of coal replaced by one ton of oil	—	2·0	2·6

* A box (31,360 sq. in) of tinplate is a measure of sheet area.

These results are the average of several weeks' working and are clear evidence that oil-fired mill furnaces are more efficient than either gas-fired or coal-fired units. It may be added that the quality of the tinplate has been improved by conversion to oil, and the efficiency of the operatives has increased due to the improvement in working conditions and atmosphere—i.e. the absence of smoke and dust and the elimination of the arduous work of stoking and raking coal fires. Furnace maintenance has been reduced and outputs have been increased by 10 per cent.

SHEET ANNEALING FURNACES

One of the final processes in the production of steel sheet and tinplate is annealing, and this is a heat process which, as all metallurgists know, must be carried out under very exact conditions. To produce the type of sheet required in industry the temperature of the sheets must follow a pre-determined cycle of heating, soaking and cooling, and the time/temperature curve of this cycle must be adhered to rigidly. In

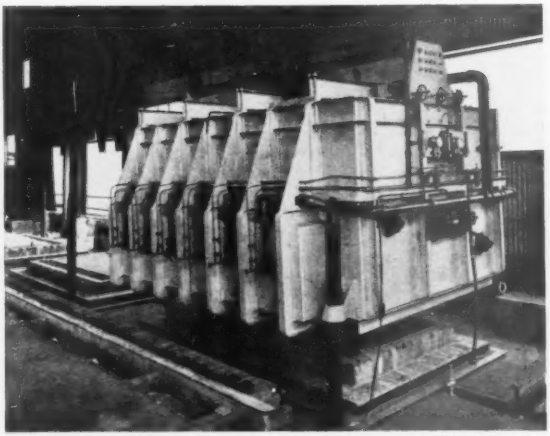
addition, the atmosphere in the furnace must be such that there is absolutely no scale on the finished product, not even a trace of discolouration or "blueing". Furnaces to give the required conditions were first developed some fifteen years ago and are now fairly well known as bell-type annealing furnaces.

Several beds of refractory brick are built on the floor of the annealing shop and the steel sheets to be annealed are stacked on a thick layer of sand covering the refractory bed. They are then covered by a steel box or hood, the lower edges of which are sunk into the layer of sand so forming a gas-tight seal. The air in the hood is then purged by town gas or clean producer gas, which is continually passed through during the heating and cooling cycle, the quantity passing through being comparatively small and controlled by a valve at the outlet where the gas is burnt to atmosphere. The gas enters and leaves the hood through the bed. The steel sheets are, therefore, always in an inert atmosphere free from oxygen, and remain on their beds under the hoods during the complete heating cycle, the hoods not being removed until the sheets are cold and ready for disposal as annealed sheets.

The actual furnace used for the heating is a rectangular box open at the bottom, generally termed a bell, which is lowered on to the refractory bed, so completely covering the hood and stack of sheets inside. The bell is lined with refractory, insulated, and, of course, carries the burners or heating devices used for heating the whole structure.

One furnace bell can be used for several beds; it can be heating one while a second is cooling, a third being unpacked, and a fourth being stacked ready for annealing. Usually one bell serves five beds.

The need for accurate temperature control is so important that several thermocouples are inserted in different parts of the stack of sheets, their leads being taken through the bed to a recording instrument which can be used to actuate automatic control. Fig. 1 illustrates an oil-fired bell annealing furnace in a half lowered position. The refractory beds on which the sheets are stacked are also visible.



[Courtesy of Gibbons Bros. Ltd.

Fig. 1. Oil-fired bell annealing furnace for steel sheets

It will be realized from the description of this furnace and process that the method of heating will be an important factor. The process demands cleanlines and accuracy of control while the furnace design and construction makes it impossible to use anything but a fluid fuel. The choice of fuels is, therefore, confined to electricity, gas and oil. Some of the earliest furnaces were developed for electricity with electric

resistors fixed to the inside walls of the furnace bell. However, the cost of using electricity on these lines was high, and development of this form of heating has been directed to the more complicated continuous bright annealing furnaces, which are outside the purview of this article.

Both town gas and clean producer gas have been, and still are, being extensively used in bell-type annealing furnaces. The method of application has, however, tended to keep the thermal efficiency of the furnace low and operating costs relatively high. As a corollary to the low thermal efficiency, the fuel economy efficiency,* calculated back to the basic fuel (coal), is also extremely low and, therefore, the use of gas may be regarded as a doubtful proposition when considered from the national aspect.

For gas firing, 5-inch or 6-inch diameter steel tubes are usually employed, arranged vertically along the inner face of the furnace side walls. They are generally inserted through the lower portion of the wall and are taken out at the top, each tube being equipped with its own gas burner, combustion taking place within the tube. Heating of the hood and sheets is entirely by radiation from the red hot tube, no products of combustion coming into contact with the inner hood. The waste gases must leave the tubes at the temperature of the tubes and, in consequence, an appreciable amount of useful heat is wasted.

Some nine months ago, the first oil-fired bell annealing furnace was put in operation and has given very satisfactory results. The success of the design was in no small measure due to the close and friendly collaboration between the user, the furnace builder and technicians from the oil industry. At the start it was realized that multiple burners, each passing less than half a gallon of oil an hour, would have to be used to give even distribution of heat along each side of the furnace. Medium-pressure air-jet burners of special design were, therefore, chosen using air for atomization at 3 to 4 p.s.i. with secondary air through a forced draught casing at about 2 inches w.g. These burners give very stable flames with good combustion conditions, CO_2 readings of 12 to 13 per cent being recorded. Each burner fires into its own combustion chamber, the end of the chamber nearest the hood being covered by a vertical refractory tile arranged with a small gap at the bottom so that gases are permitted to enter the space between the side walls and the hood. By this arrangement there is an extensive radiating surface of hot refractory along the whole length of the lower half of each side of the furnace. In addition to this heating by radiation, there is an appreciable amount of heating by convection from the products of combustion travelling up the sides and over the top of the hood.

In the first design, gases are leaving the furnace direct to atmosphere, but in future designs it is considered that good use can be made of the waste gases by taking them through flues to a second bed of sheets, protected by their hood, the whole being covered by a simple well insulated bell. By this means, a stack of sheets will receive a useful amount of preheat, which should reduce the total oil consumption considerably.

The electrically driven compressor and fan are mounted on top of the bell, electric leads being taken to plug connections alongside each bed. Oil is supplied by a ring main running the length of the shop, branch lines being run from this ring main to points alongside each bed. In Fig. 1 the end of this branch line with its shut off valve can be seen together with the flexible connexion to the oil line running round the furnace and supplying the burners.

* See Richardson—"Fuel and Power", page 241 of this issue.

The average results obtained on this new oil-fired bell annealing furnace are given in Table II.

TABLE II

	Annealing mild steel sheet	*Annealing electrical sheet*
Average weight per charge	14 tons	14 tons
Average time per cycle	18–20 hours	28 hours
Temperature ..	650°C	750°C
Average gallons of oil per ton	6–7	8–9

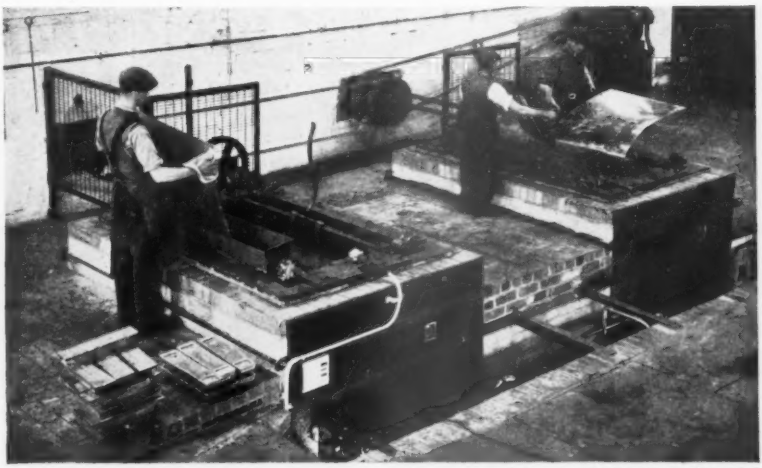
Unfortunately, no furnace of exactly similar capacity operating on gas is in use, and, therefore, it is not possible to give comparative data. However, the user is satisfied that fuel costs have been reduced by 30 to 40 per cent, and that times per heating cycle have also been considerably reduced, so increasing the output from the furnaces.

TERNE POTS

The tinning of steel sheet is well known as a process for the production of material for the manufacture of metal containers for food products. The terne coating of sheets, however, is probably little known outside the steel industry and certain manufacturers using the product. Terne is an alloy of tin and lead used for coating sheets employed where bare steel would be unsatisfactory and tinned sheet unnecessarily expensive. Petrol cans are an example of containers made from terne coated sheet.

The process consists of passing sheets, previously pickled through baths of the molten alloy. In the first bath the sheets are passed through a flux into the molten metal and in the second through palm oil into the molten metal, after which they go through finishing rollers. The sheets are often moved from the first bath to the second by hand. The final sheet is evenly coated with an almost mirror-like surface. The baths are of cast-iron and are built into individual furnace settings.

It is important that the molten metal shall be at an even temperature throughout so that the sheets shall be coated evenly, and the temperature must be



[Courtesy of NuWay Heating Plants Ltd.

Fig. 2. Oil-fired terne pots

kept within fairly fine limits. If the metal is too cold the sheets will pick up too thick a coating, and if too hot the coating will be too thin and the alloy will tend to oxidize and dross. It will be appreciated that cleanliness is also of vital importance as ash or solid particles in the atmosphere may scratch the finished surface and detract from its appearance. Labour conditions have also to be considered as the furnace operators usually attend to the firing and, therefore, ease of firing and control will contribute to better output.

The fuel used for this process will, therefore, have a direct bearing on the results obtained. It must be capable of giving an even heat distribution, it must be easily controllable, and it must be clean and burn without ash. Fuel oil is eminently suitable.

Fig. 2 illustrates a pair of terne pots specially designed for oil-firing which have been in successful use for some twelve months. The furnace nearest the camera is the first bath through which the cold sheets are passed, the final terne coated sheet can be seen issuing from the second furnace on the right of the picture.

Two gas passages are arranged underneath the bath, the oil burner firing down the first and the products of combustion coming back down the second. The waste gases from the first bath are taken through a duct in the floor to the second bath where they pass underneath, again through two gas passages. A small auxiliary burner is fitted to this bath for supplying extra heat for "topping up" the waste gases when necessary.

The burners selected were low pressure air burners, the main one being automatically controlled and the auxiliary one hand-controlled. The make of burner chosen was one designed so that the air stream passing over the oil jet creates sufficient vacuum at that point to suck the oil from a small heated service tank and deliver it into the air stream. By varying the volume of air through the burner, it is possible to vary the oil so delivered in the same ratio. A motorized valve is, therefore, inserted in the air line and is operated through an indicating pyrometer by a thermocouple in the molten metal. The burner operates by this means on the high-low flame principle.

As regards the construction of the furnaces, these, with the exception of the combustion chambers, are built of insulating refractory backed by insulating bricks. The combustion chambers are built of first-class fire brick with silicon carbide arches to give even heat transfer to the bath in the first gas pass. In order to reduce heat losses from the top of the baths, insulated covers are fitted over the centre portions.

In any heating process, the design of furnace and the fuel chosen must be linked together if the best results are to be obtained. This terne pot is an excellent example of how full use can be made of the technical advantages of the fuel to design a very economical and efficient furnace, and the excellent results quoted in Table III are ample confirmation of this.

TABLE III

	Oil-fired pots	*Coal-fired pots*
Average output per week ..	103 tons	85 tons
Average fuel consumption per week	1·61 „	13 „
Average fuel consumption per ton	36 lb	342 lb
Average therms per ton ..	6·75	42·75
Therms of coal replaced by one therm of oil	—	6·3
Tons of coal replaced by one ton of oil	—	9·5

"Every fuel presents its own special technical features, which have to be viewed in relation to its cost and availability, and in the present critical situation it is essential that each of them should be employed for those purposes for which it is best suited and will give the best return, i.e., maximum output for minimum expenditure of

heat. In other words, care must be taken to choose the RIGHT FUEL FOR THE JOB."*

It is hoped that the three applications of oil described in this article will give an indication of a few of the many types of job for which *oil* can be regarded as *the right fuel.*

In conclusion, the author would like to pay grateful acknowledgment to Messrs Richard Thomas & Baldwin, Ltd., Stourport-on-Severn, and The Eaglesbush Tinplate Works, Ltd., Neath, for data regarding fuel consumptions, etc, and for permission to publish these results.

BRITISH OIL EQUIPMENT

Report of the C.B.M.P.E.

In his Report for 1946–47 Mr S. T. Robson, chairman of the Council of British Manufacturers of Petroleum Equipment, emphasized the scope of the oil industry and the opportunities it offers to British industry. It had been shown, he said, that during 1946 the oil companies spent £33½ million in Great Britain on equipment and material, nearly all for overseas. For the first six months of 1947 the comparable figure was £20 million.

Considerable impetus has been given to the work of the Council by the results of the Mission to the Caribbean. Mr Robson hoped that early in 1948 the Council would have a similar picture of the Middle East oilfields because, at the invitation of British companies operating there, he proposed to tour that area to discuss problems, developments, and conditions.

Referring to the publications of the Council, Mr Robson mentioned the first edition of *British Petroleum Equipment* and their newer publication, the *Quarterly Magazine.*

STANDARDIZATION

Mr T. L. Bonstow, director of the Council, reported on the work of the Technical Committees and of the B.S.I. Committees, and stressed the assistance given in the work by the many organizations which collaborated at the B.S.I. The year had been one of achievement, he said, and the drafts now going out to industry were arousing considerable interest and valuable comment.

Mr Bonstow said that he regarded the standardization work as a mark of the determination of the members to develop and expand the production of petroleum equipment in Great Britain. There were still gaps in the gamut of equipment which could be supplied from Britain, he said, and he concluded by stressing that the petroleum industry was progressing and that equipment for it, therefore, had to be progressive also. He thought that the petro-chemical industry was on the eve of an enormous step forward and offered great opportunities to the suppliers of its equipment.

LIQUID FUEL INSTALLATIONS COMMITTEE

THE Liquid Fuel Installations Committee of the Institute of Petroleum, convened in 1945 at the invitation of the Minister of Fuel and Power, is engaged in preparing a report on the use of liquid fuels for the heat services of buildings. The report, which is now in an advanced stage of preparation, will deal in considerable detail with the technique of using kerosine, liquid gas (butane), fuel oils, and creosote-pitch mixture for the space heating and domestic hot water requirements of buildings of a domestic character, from the small dwelling of local authority type to large hotels and office blocks. It is hoped the report will be ready for publication at the end of this year.

* See Bailey, Battershill & Bressey, "Liquid Fuel for High Temperature Processes"—Supplement to the *I.P. Review*, January 1947.

CORRESPONDENCE

SOME AMERICAN THOUGHTS ON TOMORROW'S OIL

The Editor, *I.P. Review*.

Dear Sir,

One of my colleagues has drawn my attention to a rather misleading statement in Lt.-Col. Auld's paper, appearing in your April issue. The last paragraph on page 102 reads in part:

> It must be remembered that the coals of America are very largely anthracitic and bituminous in nature.

In actual fact, there are enormous reserves of lignite, mainly in Montana and North Dakota, and of sub-bituminous coals mainly in Wyoming and Colorado. Reserves in billions of tons have been estimated as:

Anthracite . .	15.39
Bituminous . .	1407.82
Sub-bituminous .	818.08
Lignite . . .	939.37
Total . . .	3180.66

From these figures it will be observed that nearly 30 per cent of the United States' coal reserves are lignitic, and more than half are lignitic or sub-bituminous in nature. The fact that lower-grade coals have not yet been worked, except very locally and on an insignificant scale, may of course be ascribed to the abundance of anthracitic and bituminous coals.

In a long-range view, however, and because of the comparative simplicity of lignites as a raw material for the synthesis of petroleum, the reserves of lower-grade coals are very important. It is unlikely that any important amount of anthracite or bituminous coal will be used for synthesis for a long time to come.

Yours truly,
JOHN HAWORTH.

The Texas Company,
135 East 42nd Street,
New York 17, N.Y., U.S.A.

A WORLD OIL MAP

A USEFUL wall map of the world's oil industry has just been issued by the Petroleum Information Bureau. The map, which is 37½ in by 19 in shows by coloured symbols the country locations of oilfields and refineries, the size of the symbols indicating the magnitude of production or capacity. Panels below the map amplify statistically the data given on the map, and revised panels will be issued annually. Copies are available from the Bureau, 46, St. James' Place, London, S.W.1.

INDEX TO A.S.T.M. STANDARDS

JUST published is the 242-page Index to A.S.T.M. Standards as of December 1946. This publication, which is available without charge on application to A.S.T.M. Headquarters, 1916 Race Street, Philadelphia 3, Pa., U.S.A., enables any of the 1400 standard specifications and tests in the 1946 Book of Standards to be readily located. It is also of service to those who wish to ascertain whether a particular test or specification has been standardized by the A.S.T.M. All items are listed under appropriate keywords; A list in numerical sequence is also provided.

INSTITUTE SCHOLARSHIP

THE Institute Scholarship at the Imperial College, London, has been awarded to C. A. Fothergill, who was nominated by the College Board of Studies for excellent work in the third year course in oil technology during the session 1946-47.

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OIL WEEKLY

The well-known U.S. petroleum publication *Oil Weekly*, published under that name for 27 years, is now making its appearance under the name of *World Oil*, it being intended to devote more space to activities outside the United States.

Powell Duffryn Ltd., through its subsidiary, Delanium Ltd., has for some time been engaged in research and development work in relation to carbon products at laboratories in Battersea. A new company, Powell Duffryn Carbon Products Ltd., has been formed to undertake production of such carbon products at Hayes, Middlesex, and the name of Delanium Ltd., has been changed to Powell Duffryn Research Laboratories Ltd.

FORTHCOMING MEETINGS

INSTITUTE MEETINGS

Metallurgical Methods for Combating Corrosion and Abrasion in the Petroleum Industry. B. B. Morton. At 26 Portland Place, London, W.1, 5 p.m., October 9.

Rheological Investigation of Asphaltic Bitumen in Connexion with its Technical Applications. R. N. J. Saal. At 26 Portland Place, London, W.1, 5 p.m., November 12.

MEETINGS OF OTHER SOCIETIES

The Engining of Cargo Vessels of High Power. Symposium. The Institute of Marine Engineers, London, 2.30 p.m. November 11 and 12.

The Burning of Boiler Fuels in Diesel Engines. J. Lamb. The Institute of Marine Engineers, London, 5 p.m. December 9.

Richard Klinger Ltd., makers of asbestos jointing and boiler fittings, have opened a new branch office and depot at 19 Queen Street, Newcastle-on-Tyne.

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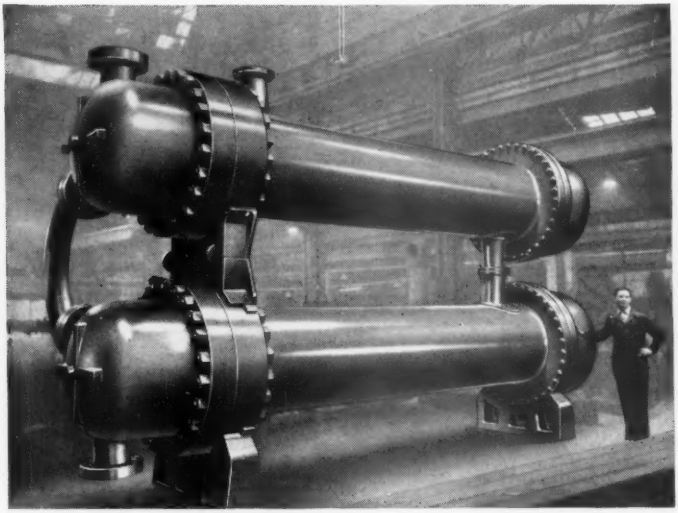

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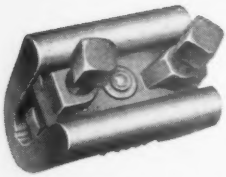

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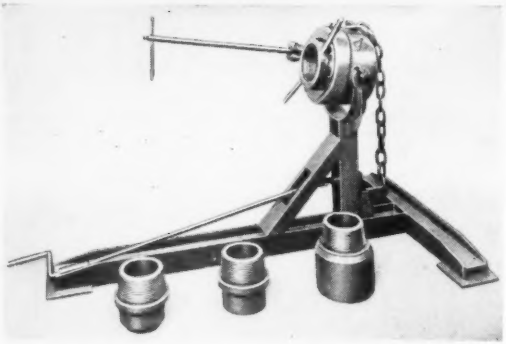

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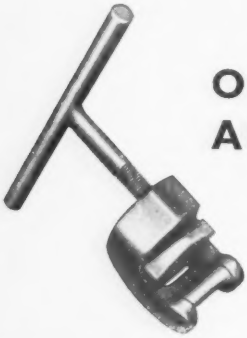

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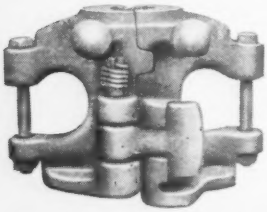

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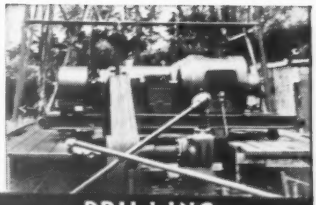

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